

Spatiotemporal variation of excess all-cause mortality in the world (125 countries) during the Covid period 2020-2023 regarding socio-economic factors and public-health and medical interventions

Denis G. Rancourt^{*1}; Joseph Hickey^{1 2}; Christian Linard²

¹ Correlation Research in the Public Interest (correlation-canada.org)

² Université du Québec à Trois-Rivières (<http://www.uqtr.ca/PagePerso/Christian.Linard>)

* denis.rancourt@gmail.com

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Citation: Denis G. Rancourt, Joseph Hickey, Christian Linard. Spatiotemporal variation of excess all-cause mortality in the world (125 countries) during the Covid period 2020-2023 regarding socio economic factors and public-health and medical interventions. CORRELATION Research in the Public Interest, Report, 19 July 2024. <https://correlation-canada.org/covid-excess-mortality-125-countries>

Summary

We studied all-cause mortality in 125 countries with available all-cause mortality data by time (week or month), starting several years prior to the declared pandemic, and for up

to and more than three years of the Covid period (2020-2023). The studied countries are on six continents and comprise approximately 35 % of the global population (2.70 billion of 7.76 billion, in 2019).

The overall excess all-cause mortality rate in the 93 countries with sufficient data in the 3-year period 2020-2022 is 0.392 ± 0.002 % of 2021 population, which is comparable to the historic rate of approximately 0.97 % of population over the course of the 1918 “Spanish Flu” pandemic.

By comparison, India (which is not included in the present study) had an April-July 2021 peak in excess all-cause mortality of 3.7 million deaths for its 2021 population of approximately 1.41 billion, which corresponds to an excess death rate of 0.26 % for 2021 alone (Rancourt, 2022).

Our calculated excess mortality rate (0.392 ± 0.002 %) corresponds to 30.9 ± 0.2 million excess deaths projected to have occurred globally for the 3-year period 2020-2022, from all causes of excess mortality during this period.

We also calculate the population-wide risk of death per injection (vDFR) by dose number (1st dose, 2nd dose, boosters) (actually, by time period), and by age (in a subset of European countries). Using the median value of all-ages vDFR for 2021-2022 for the 78 countries with sufficient data gives an estimated projected global all-ages excess mortality associated with the COVID-19 vaccine rollouts up to 30 December 2022: 16.9 million COVID-19-vaccine-associated deaths.

Large differences in excess all-cause mortality rate (by population) and in age-and-health-status-adjusted (P-score) mortality are incompatible with a viral pandemic spread hypothesis and are strongly associated with the combination (product) of share of population that is elderly (60+ years) and share of population living in poverty.

There are large North-South (Canada-USA-Mexico) differences in North America, and large East-West differences in Europe, which are due to large national jurisdictional differences, or discontinuities in socio-economic and institutional conditions. Such systematic differences in mortality and underlying structure are captured by hierarchical cluster analysis using a panel of (yearly) time series, including to some extent the likelihood of persistent excess all-cause mortality into 2023.

Excluding borderline cases, 28 countries (of 79 countries with sufficient data, 35 % of countries) have a high statistical certainty of persistent and significant excess all-cause mortality into 2023, compared to the extrapolated pre-Covid historic trend, excluding excess all-cause mortality from peak residuals extending out from 2022, and excluding accidentally large values: Australia, Austria, Belgium, Brazil, Canada, Denmark, Ecuador, Egypt, Finland, Germany, Ireland, Israel, Italy, Japan, Lithuania, Netherlands, Norway, Portugal, Puerto Rico, Qatar, Singapore, South Korea, Spain, Sweden, Taiwan, Thailand, United Kingdom, and USA. More research is needed to elucidate this phenomenon.

The spatiotemporal variations in national excess all-cause mortality rates allow us to conclude that the Covid-period (2020-2023) excess all-cause mortality in the world is incompatible with a pandemic viral respiratory disease as a primary cause of death. This hypothesis, although believed to be supported by testing campaigns, should be abandoned.

Inconsistencies that disprove the hypothesis of a viral respiratory pandemic to explain excess all-cause mortality during the Covid period are seen on a global scale and include the following.

- Near-synchronicity of onset, across several continents, of surges in excess mortality occurring immediately when a pandemic is declared by the WHO (11 March 2020), and never prior to pandemic announcement in any country

- Excessively large country-to-country heterogeneity of the age-and-health-status-adjusted (P-score) mortality during the Covid period, including across shared borders between adjacent countries, and including in all time periods down to half years
- Highly time variable age-and-health-status-adjusted (P-score) mortality in individual countries during and after the Covid period, including more-than-year-long periods of zero excess mortality, long-duration plateaus or regimes of high excess mortality, single peaks versus many recurring peaks, and persistent high excess mortality after a pandemic is declared to have ended (5 May 2023)
- Strong correlations (all-country scatter plots) between excess all-cause mortality rates and socio-economic factors (esp. measures of poverty) change with time (by year and half year) during the Covid period, between diametrically opposite values (near-zero, large and positive, large and negative) of the Pearson correlation coefficient (e.g., Figure 29, first half of 2020 to first half of 2023)

One might tentatively add:

- No evidence of the large vaccine rollouts ever being associated with reductions in excess all-cause mortality, in any country (and see Rancourt and Hickey, 2023)
- Exponential increases with age in excess all-cause mortality rate (by population), consistent with age-dominant frailty rather than infection in the limit of high virulence

We describe plausible mechanisms and argue that the three primary causes of death associated with the excess all-cause mortality during (and after) the Covid period are:

- (1) Biological (including psychological) stress from mandates such as lockdowns and associated socio-economic structural changes
- (2) Non-COVID-19-vaccine medical interventions such as mechanical ventilators and drugs (including denial of treatment with antibiotics)

(3) COVID-19 vaccine injection rollouts, including repeated rollouts on the same populations

In all cases — for all three identified primary causes of death — a proximal or clinical cause of death associated (such as on death certificates) with the quantified excess all-cause mortality is respiratory condition or infection. Therefore, we distinguish (and define) true primary causes of death from the pervasive and accompanying proximal or clinical cause of death as respiratory.

We understand the Covid-period mortality catastrophe to be precisely what happens when governments cause global disruptions and assaults against populations. We emphasize the importance of biological stress from sudden and profound structural societal changes and of medical assaults (including denial of treatment for bacterial pneumonias, repeated vaccine injections, etc.). We estimate that such a campaign of disruptions and assaults in a modern world will produce a global all-ages mortality rate of $>0.1\%$ of population per year, as was also the case in the 1918 mortality catastrophe.

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1 Introduction

All-cause mortality by time and by administrative jurisdiction is arguably the most reliable data for detecting and epidemiologically characterizing events causing death, and for gauging the population-level impact of any surge or collapse in deaths from any cause. Such data can be collected by national or state jurisdiction or subdivision, by age, by sex, by location of death, and so on. It is not susceptible to reporting bias or to any bias in attributing causes of death in the mortality itself (see many references in Rancourt et al., 2023a).

Rancourt and collaborators have studied all-cause mortality for many jurisdictions, while developing the analytic approaches:

- several, esp. USA (Rancourt, 2020);
- France (Rancourt et al., 2020);
- India (Rancourt, 2022);
- USA (Rancourt et al., 2021a, 2022b);
- Canada (Rancourt et al., 2021b, 2022c);
- Australia (Rancourt et al., 2022a, 2023b);
- 17 countries in the Southern Hemisphere (Rancourt et al., 2023a);
- Israel (Rancourt et al., 2023b);
- world, with respect to COVID-19 vaccine efficacy (Rancourt and Hickey, 2023).

Researchers at CORRELATION and collaborators continue to be engaged in a broad research program of all-cause mortality and its associations with various factors: <https://correlation-canada.org/research/>

Here we study all-cause mortality in 125 countries with available all-cause mortality data by time (week or month). The studied countries are on six continents and comprise approximately 35 % of the global population (2.70 billion of 7.76 billion, in 2019).

Large countries which are notably excluded for lack of available data include China (1.41 billion in 2019), India (1.38 billion in 2029), Indonesia, Pakistan, and most countries in Africa, although India has previously been studied (Rancourt, 2022; and references therein).

See the Summary for an overview.

2 Data

Our main source of all-cause mortality data is the World Mortality Project (WMP) (Karlinsky and Kobak, 2021). (References for this section are immediately below.)

For Chile, we used the data from the Organisation for Economic Co-operation and Development (OECD, 2024) due to the absence of data for the year 2015 for Chile in the WMP datafile.

Additional all-cause mortality data by age group and sex for European countries are from Eurostat (Eurostat, 2024a).

COVID-19 vaccination data are from Our World in Data (Mathieu et al., 2020), the World Health Organization (WHO, 2024), and the European Centre for Disease Prevention and Control (ECDC, 2023).

Socio-economic data are from OWID's curation of the World Bank's Poverty and Inequality Platform data (Hasell and Arriagada, 2023), OWID's Population and Demography Data Explorer (OWID, 2024d) and the United Nation's World Population Prospects 2022 (United Nations, 2022).

National population data are from the World Bank (World Bank, 2023), and additional population data by age group and sex are from Eurostat (Eurostat, 2024b).

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3 Methods

3.1 Excess all-cause mortality by time

Excess all-cause mortality by time (week or month) and its one-standard-deviation uncertainty are calculated as follows. We first applied this method in Rancourt and Hickey (2023). We believe that this simple and direct method is itself a significant advance in the methodology of analyzing all-cause mortality data, which does not introduce uncertainty from arbitrary choices or tenuous extrapolation algorithms.

The excess all-cause mortality at a given time (week or month) is the difference (positive or negative) between the reported all-cause mortality for the given time and the expected all-cause mortality for the given time, which is ascertained from the historic all-cause mortality in a reference period immediately preceding the Covid period (prior to the 11 March 2020 World Health Organization declaration of a pandemic).

In practice, our reference period is 2015 through 2019, except in the few countries for which the mortality data does not extend as far back as 2015 and may begin in 2017 and 2019, for example. We least-squares fit a straight line to the same week or month in each of the five (or less) reference years as the week or month of interest, where the slope of this fitted line is constrained to always (for every week or month of interest) be equal to the slope of a least-squares fitted line to all of the all-cause mortality data (all weeks or months) in the full 5-year (or less) reference period, for each given country.

The thus obtained fitted line is used (by extrapolation) to predict the expected all-cause mortality. The one-standard-deviation (1σ) uncertainty in the expected all-cause mortality is estimated as $\sqrt{\pi/2}$ times the average magnitude of the 5 (or less) deviations in the 2015-2019 (or shorter) reference period, for each particular week or month of interest. This simple relation is exact in the limit of a large sampling number, for a normally distributed uncertainty.

Finally, the one-standard-deviation uncertainty of the excess mortality is the combined error that includes the 1σ uncertainty in the expected value and the independent statistical (1σ) error in the all-cause mortality (\sqrt{N}).

3.2 Hierarchical clustering

We use the hierarchical clustering algorithms provided in the SciPy library (Python) (SciPy, 2024). The input data is an array in which the rows are country indexes and the columns are the country's total annual all-cause mortality for each of the years 2019, 2020, 2021 and 2022. The input data is thus a panel of time-series, with one time-series consisting of four data-points for each country.

We use the `scipy.cluster.hierarchy.linkage` function with options `method='complete'` and `metric='correlation'` to produce a hierarchical clustering grouping countries with similar time-series together. We then use the `scipy.cluster.hierarchy.fcluster` function with option `criterion='distance'` to obtain three clusters at a threshold distance value equal to 1 (y-axis of the dendrogram in Figure 12).

4 Results and interpretive context

4.1 General overview of the mortality data

The core data in this study is national all-cause mortality by time (week, month, year). There are large anomalous variations in this mortality data during the Covid period

(2020-2023), compared to historic seasonal and regional variations, both by time and by national jurisdiction.

Strictly speaking, the Covid period can be defined to start at the 11 March 2020 World Health Organization (WHO) declaration of a pandemic and to end at the 5 May 2023 WHO declaration of the end of the declared pandemic.

The time and jurisdictional changes during the Covid period are so large and varied that the data itself and the extracted excess all-cause mortality need to be shown for each country having available data. There is no substitute for that.

In the figure of **Appendix A**, each of the 125 countries has a panel. Each panel has two parts:

- (1) Top part: Reported all-cause mortality (blue), by week or by month, and predicted (from the historic or recent pre-Covid period, see Methods) all-cause mortality (orange), 2015-2023, with shaded 1σ -error ranges.
- (2) Bottom part: Calculated excess all-cause mortality (green), by week or by month, 2015-2023, with shaded 1σ -error range.

Here, the WHO dates of 11 March 2020 (declaration of a pandemic) and 5 May 2023 (end of declaration) are shown in each panel by vertical grey lines. Error-range shading (1σ error, see Methods) is shown for all curves (blue, orange, green). The statistical 1σ -error for the raw all-cause mortality (blue) is generally too small to see on the figure.

Appendix A, therefore, shows the raw data and illustrates the extraction method to calculate the corresponding excess all-cause mortality. The linear extrapolation for the predicted mortality is based on the historic trend in the 2015-2019 period, or the available data within that period (see Methods).

Similarly, in the figure of **Appendix B**, each of the 125 countries has three panels:

- (1) Top panel: Reported all-cause mortality, by week or by month, and number of COVID-19 vaccine doses administered, by week or by month, 2018-2023, both normalized by the national population in 2019.
- (2) Middle panel: Calculated excess all-cause mortality, by week or by month, and number of COVID-19 vaccine doses administered, by week or by month, 2018-2023, both normalized by the national population in 2019.
- (3) Bottom panel: Cumulative excess all-cause mortality, by week or by month, and cumulative number of COVID-19 vaccine doses administered, by week or by month, 2018-2023, both normalized by the national population in 2019.

Here, the 11 March 2020 date of the WHO declaration of a pandemic is shown in each panel by a vertical grey line, and up to three sources of vaccine administration data are shown, when available.

The country-to-country variations in time-dependent all-cause mortality are striking, as are differences between the recent historic record (2015-2019) and the Covid period (**Appendix A, Appendix B**). Some general features are as follows.

- (1) There is essentially no excess mortality, in any country, prior to the 11 March 2020 WHO declaration of a pandemic.
- (2) There are various large peaks and periods of excess all-cause mortality during the Covid period.
- (3) Statistically significant peaks and increases of excess all-cause mortality occur in the Covid period in virtually all of the 125 countries, except one. Greenland (GRL) is the only exception, showing no detected excess mortality at any time, into 2023.
- (4) No characteristic or canonical or pervasive pattern of excess all-cause mortality by time in the Covid period occurs in all countries, or in most countries, or in northern latitudes, or in southern latitudes. The country-to-country differences in excess all-cause mortality are large in both normalized magnitude and temporal evolution.

- (5) Nonetheless, there are strong commonalities in excess all-cause mortality country-specific patterns within some geo-politically distinguished groups, as discussed below.
- (6) Highly unusual (unprecedented) features occur in the excess and raw mortality time patterns in the Covid period, including: anomalously large amplified seasonal peaks; large non-seasonal peaks occurring in historically observed seasons of low mortality; unique, sudden, large and sharp peaks occurring in mid or late Covid period; sustained multi-seasonal long periods of high excess all-cause mortality; and synchronicity across North or South hemispheres and between North-South hemispheres or certain sharp peaks occurring in many countries.
- (7) There is no systematic or statistically significant general or apparent trend that the large vaccination campaigns in 2021 and 2022 are associated with any reduction in excess all-cause mortality. Many countries have no excess mortality until the vaccines are rolled out. Several countries show temporal associations between vaccine rollouts and peaks or increases in all-cause mortality.
- (8) Generally speaking, excess all-cause mortality, in the cases where data is available, often persists to the end of 2022, and most often returns to small or near-zero values in 2023.
- (9) Nonetheless, there are some notable examples in which excess all-cause mortality is large in 2023, and many countries in which there is apparent moderate but sustained excess all-cause mortality into 2023. These cases are discussed below.

Some of the above-described general features can be illustrated as follows.

Figure 1 and **Figure 2** compare all-cause mortality normalized by 2019 population and excess all-cause mortality as percentage increase relative to the historic trend value (see Methods), respectively, for a large-population country with available data from

each continent. Direct comparisons are facilitated by using the same X-scale and Y-scale ranges for all the panels in a given figure.

Note that in the labels of axes and in legends in all the figures, and throughout the present article, “1e-4” or “1E-4” means “times 10^{-4} ”, and so forth (following scientific and computer-programming notation).

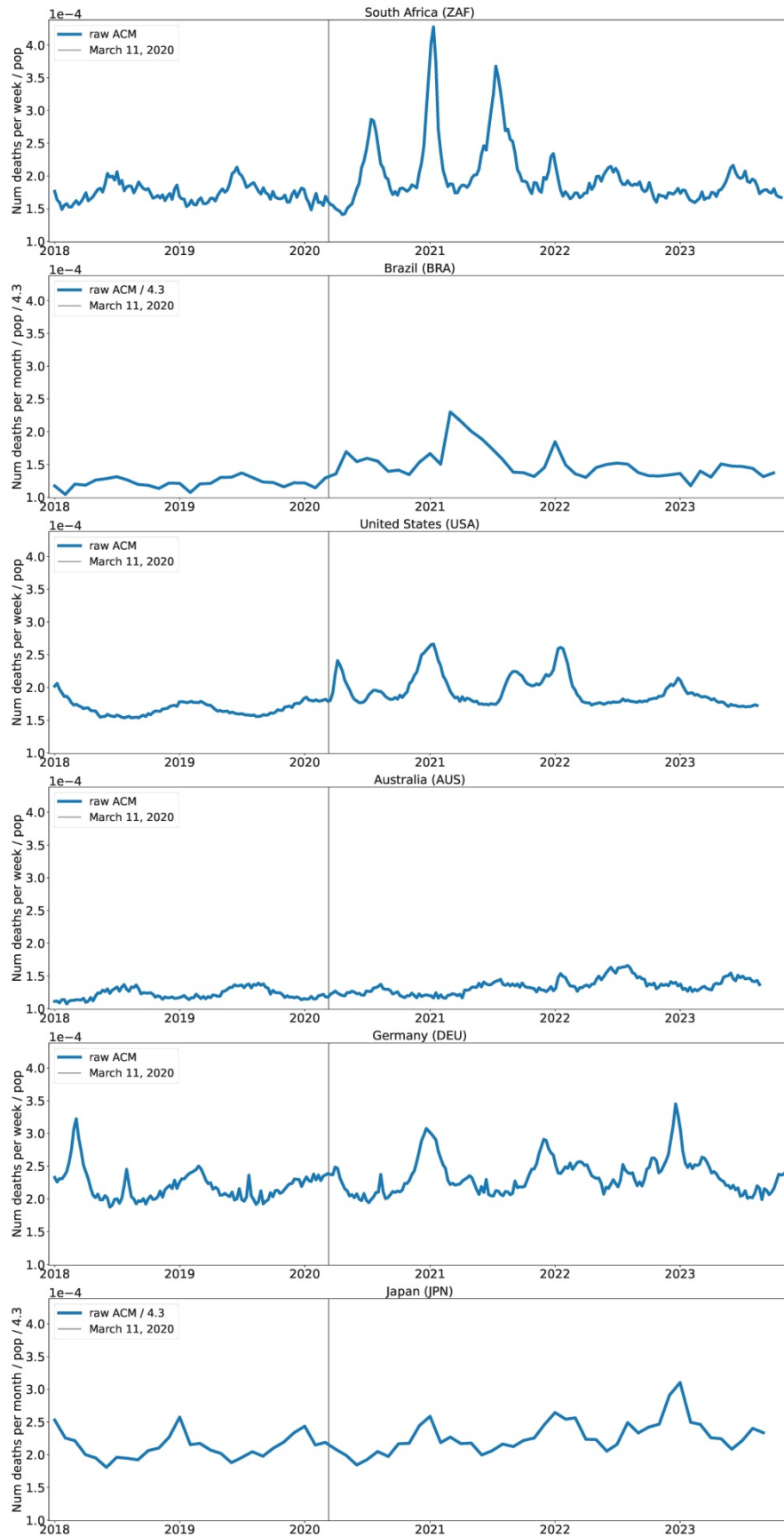


Figure 1. All-cause mortality by week or month, normalized by national 2019 population, 2018-2023, for (as per the panel labels) Australia, Brazil, Germany, Japan, South Africa, and USA, using the same Y-scale range for all panels. Each is a large-population country with available data from each continent.

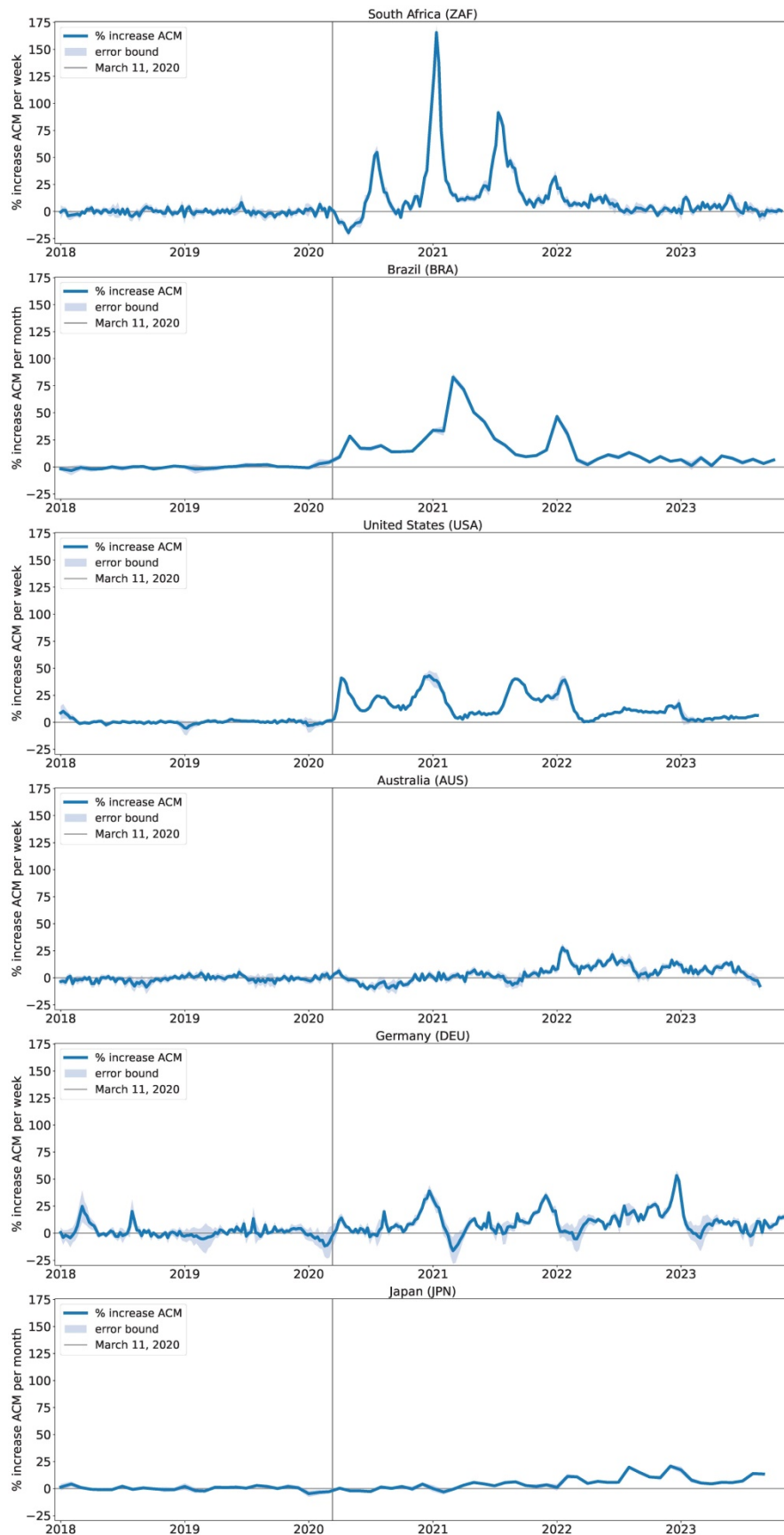


Figure 2. Excess all-cause mortality by week or month, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by week or month (“P-score”), with 1σ error bound shading, 2018-2023, for (as per the panel labels) Australia, Brazil, Germany, Japan, South Africa, and USA, using the same Y-scale range for all panels. Each is a large-population country with available data from each continent.

We stress that the illustrated large-population country in each continent is not representative of all or most of the countries in the continent (see **Appendix A** and **Appendix B**).

Next, Figure 3 and Figure 4 compare all-cause mortality normalized by 2019 population and excess all-cause mortality as percentage increase relative to the historic trend value (see Methods), respectively, for five European countries in a geographically contiguous series from West to East: Portugal, Spain, France, Germany, and Poland. Direct comparisons are facilitated by using the same X-scale and Y-scale ranges for all the panels in a given figure.

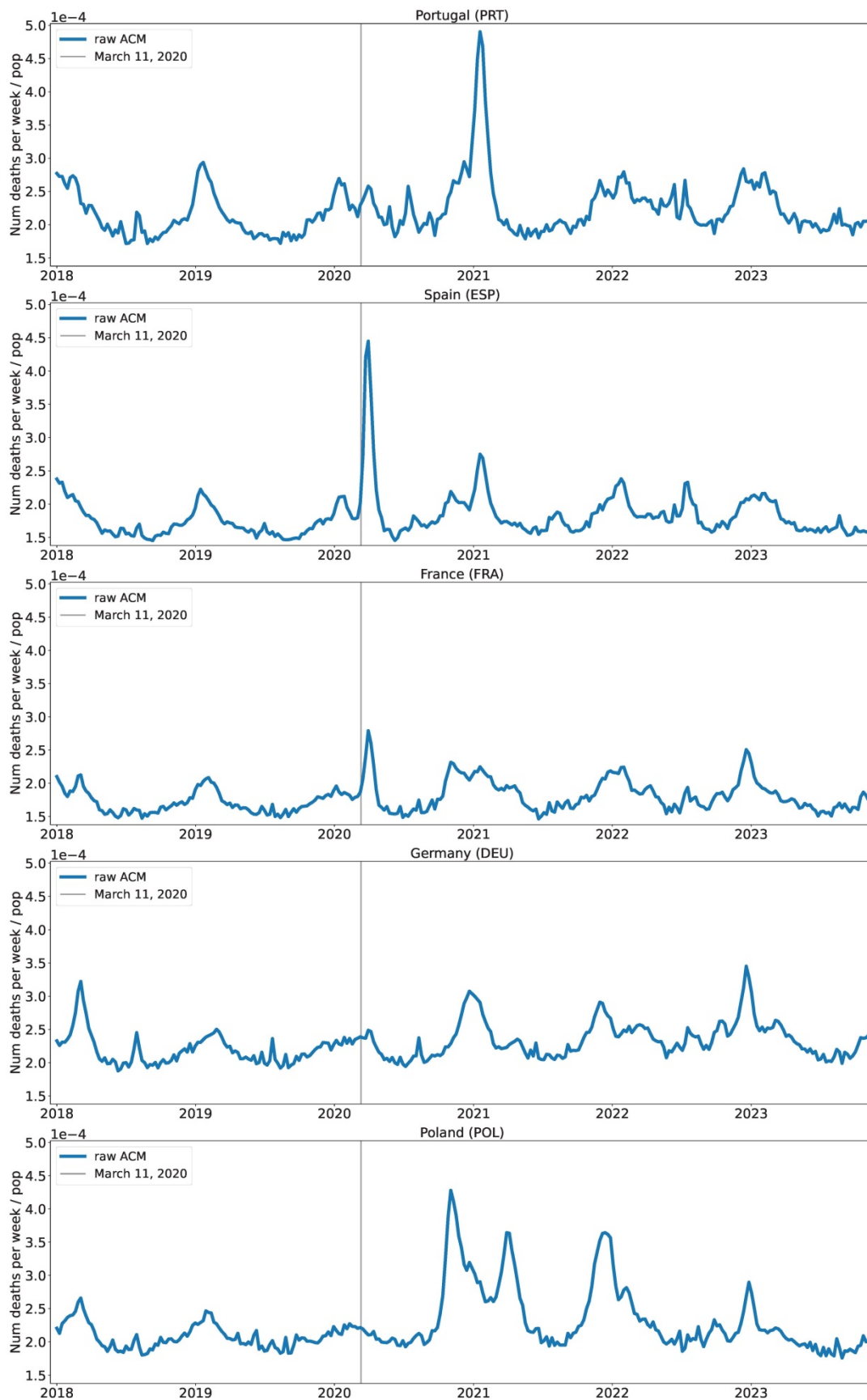


Figure 3. All-cause mortality by week, normalized by national 2019 population, 2018-2023, for five European countries in a geographically contiguous series from West to East (as per the panel labels, top to bottom): Portugal, Spain, France, Germany, and Poland, using the same Y-scale range for all panels.

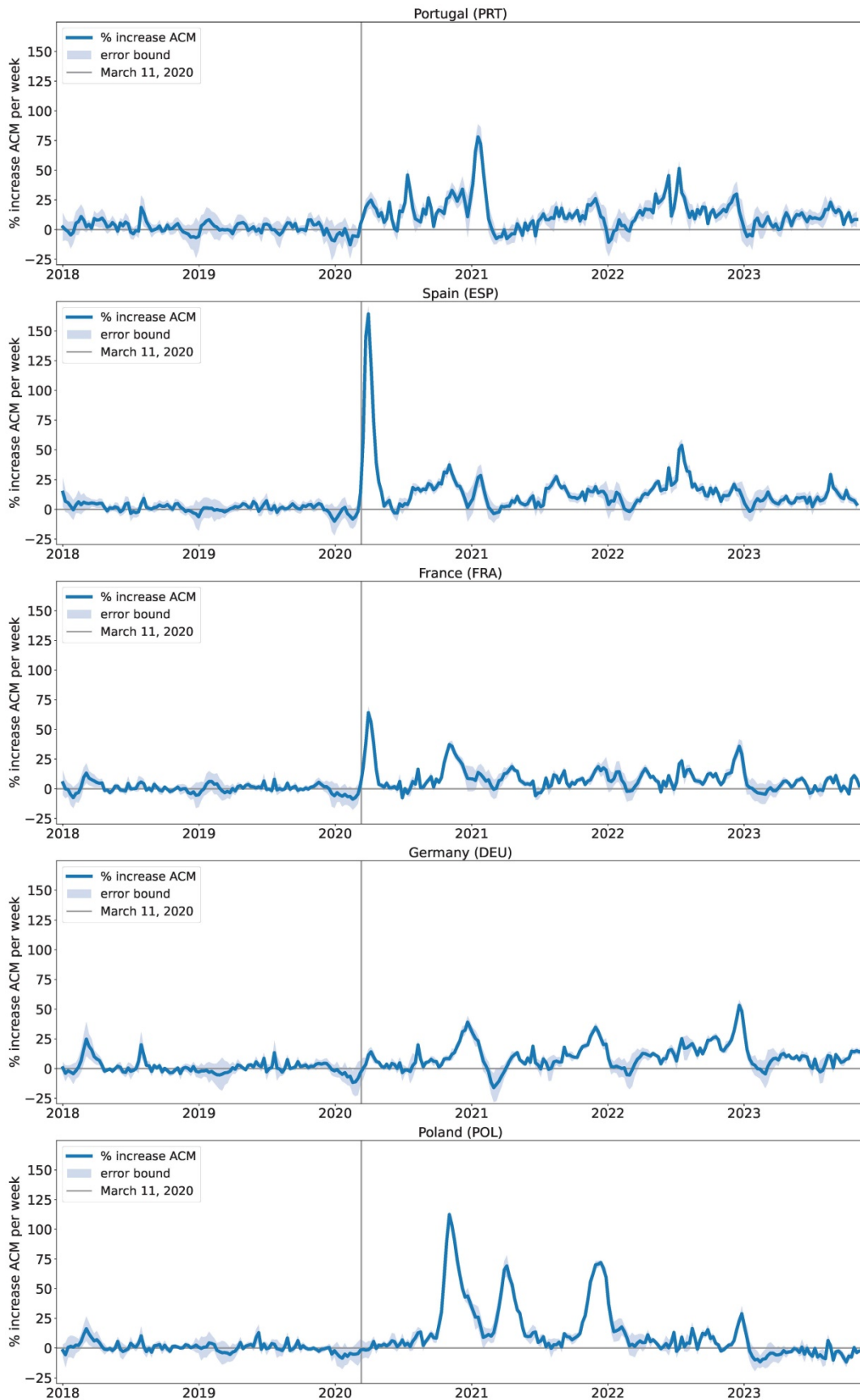


Figure 4. Excess all-cause mortality by week, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by week (“P-score”), with 1σ error bound shading, 2018-2023, for five European countries in a geographically contiguous series from West to East (as per the panel labels, top to bottom): Portugal, Spain, France, Germany, and Poland, using the same Y-scale range for all panels.

4.2 2020 March-April peak in mortality (20-3 feature)

Some understanding of the commonalities and differences in country-to-country mortality behaviours can be achieved by examining specific features or groups of features in the mortality by time curves. Examples are as follows, first in relation to the above figures.

A prominent and sharp peak in excess all-cause mortality occurs in March-April 2020, extending into May 2020, immediately following the 11 March 2020 WHO declaration of a pandemic, in Spain and France (Figure 3, Figure 4). Hereafter, we nominally refer to this peak as “20-3”, for the year 2020 and the third month. 20-3 is also prominent in the USA data (Figure 1, Figure 2), and is present as a weaker near-absent feature in the data of Portugal and Germany. 20-3 is entirely absent in the data of Australia, Japan, and South Africa. Where it does occur, it is synchronous (or it would not be “20-3”).

20-3 occurs prominently in the data of 26 (of 125) countries in the present study: Andorra, Belarus, Belgium, Brazil, Canada, Chile, Ecuador, Egypt, France, Ireland, Italy, Kuwait, Mexico, Moldova, Netherlands, Nicaragua, Peru, Qatar, San Marino, Spain, Sweden, Switzerland, Tajikistan, United Arab Emirates, United Kingdom, and USA.

20-3 occurs as a weaker near-absent feature in the data of 11 (of 125) countries in the present study: Austria, Bermuda, Colombia, Denmark, Germany, Iran, Luxembourg, Malta, Mayotte, Norway, and Portugal.

20-3 is entirely absent (undetected) in the remaining 88 (of 125) countries in the present study: Albania, Algeria, Antigua and Barbuda, Argentina, Armenia, Aruba, Australia, Azerbaijan, Bahamas, Barbados, Belize, Bolivia, Bosnia, Brunei, Bulgaria, Cabo Verde, Costa Rica, Croatia, Cuba, Cyprus, Czechia, Dominican Republic, El Salvador, Estonia, Faroe Islands, Finland, French Guiana, French Polynesia, Georgia, Gibraltar, Greece, Greenland, Guadeloupe, Guatemala, Hong Kong, Hungary, Iceland, Israel, Jamaica, Japan, Jordan, Kazakhstan, Kosovo, Kyrgyzstan, Latvia, Lebanon, Liechtenstein, Lithuania, Macao, Malaysia, Maldives, Martinique, Mauritius, Monaco, Mongolia, Montenegro, Namibia, New Caledonia, New Zealand, North Macedonia, Oman, Palestine, Panama, Paraguay, Philippines, Poland, Puerto Rico, Reunion, Romania, Russia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Serbia, Seychelles, Singapore, Slovakia, Slovenia, South Africa, South Korea, Suriname, Taiwan, Thailand, Transnistria, Tunisia, Turkey, Ukraine, Uruguay, and Uzbekistan.

Similarly, many such distinctive peaks or local increases in excess all-cause mortality are found, which are essentially synchronous when they occur, but that occur in patchy distributions around the world. In analogy with 20-3, for convenience, we nominally assign 11 more such features as: 20-6, 20-10, 21-0, 21-3, 21-6, 21-10, 22-0, 22-3, 22-6, 23-0, and 23-6. Some of these are truly distinctive features, while others are merely broader regions (in time) of excess mortality. Not all distinct features are captured by this tentative nomenclature. Here, 21-0 means a peak that straddles December 2020 and January 2021, and so forth for 22-0 and 23-0.

We further apply this nomenclature to look for definitive patterns occurring in several countries, as follows.

4.3 2020 October-November peak in mortality (20-10 feature)

The features 20-3, 20-6 and 20-10 occur prior to vaccination rollouts (**Appendix B**), and are massive in many countries.

One distinctive pattern involving 20-3, 20-6 and 20-10 can be defined as:

$$20-3 : 20-6 : 20-10 = \text{absent} : \text{absent} : \text{prominent} \quad (1)$$

Here (Equation 1), a “prominent 20-10” corresponds to a particularly deadly early Northern-Hemisphere winter of excess all-cause mortality, in the absence of prior Covid-period excess all-cause mortality. This pattern (Equation 1) captures 17 of the 124 countries with sufficient data: Belize, Bulgaria, Croatia, Czechia, Georgia, Greece, Hungary, Jordan, Liechtenstein, Lithuania, Montenegro, Poland, Romania, Russia, Transnistria, Tunisia, and Ukraine.

An associated pattern is:

$$20-3 : 20-6 : 20-10 = \text{absent} : \text{near-absent} : \text{prominent} \quad (2)$$

This pattern (Equation 2) captures 7 of the 124 countries with sufficient data: Albania, Armenia, Bosnia, Cabo Verde, Lebanon, North Macedonia, and Serbia.

We note that these similar patterns (Equations 1 and 2) capture most Eastern European countries, which all had particularly deadly early Northern-Hemisphere winters of excess all-cause mortality, prior to COVID-19 vaccination rollouts.

4.4 2022 December excess mortality peak (23-0 feature)

Another distinctive feature can be defined as:

$$23-0 : 23-6 = \text{prominent} : \text{absent or near-absent} \quad (3)$$

In the data, this corresponds to a large excess mortality peak which occurs approximately four months prior to the 5 May 2023 WHO declaration of the end of the declared pandemic, after the great majority of the COVID-19 vaccine injections have

been administered, followed by an abrupt step-wise drop in excess all-cause mortality into 2023.

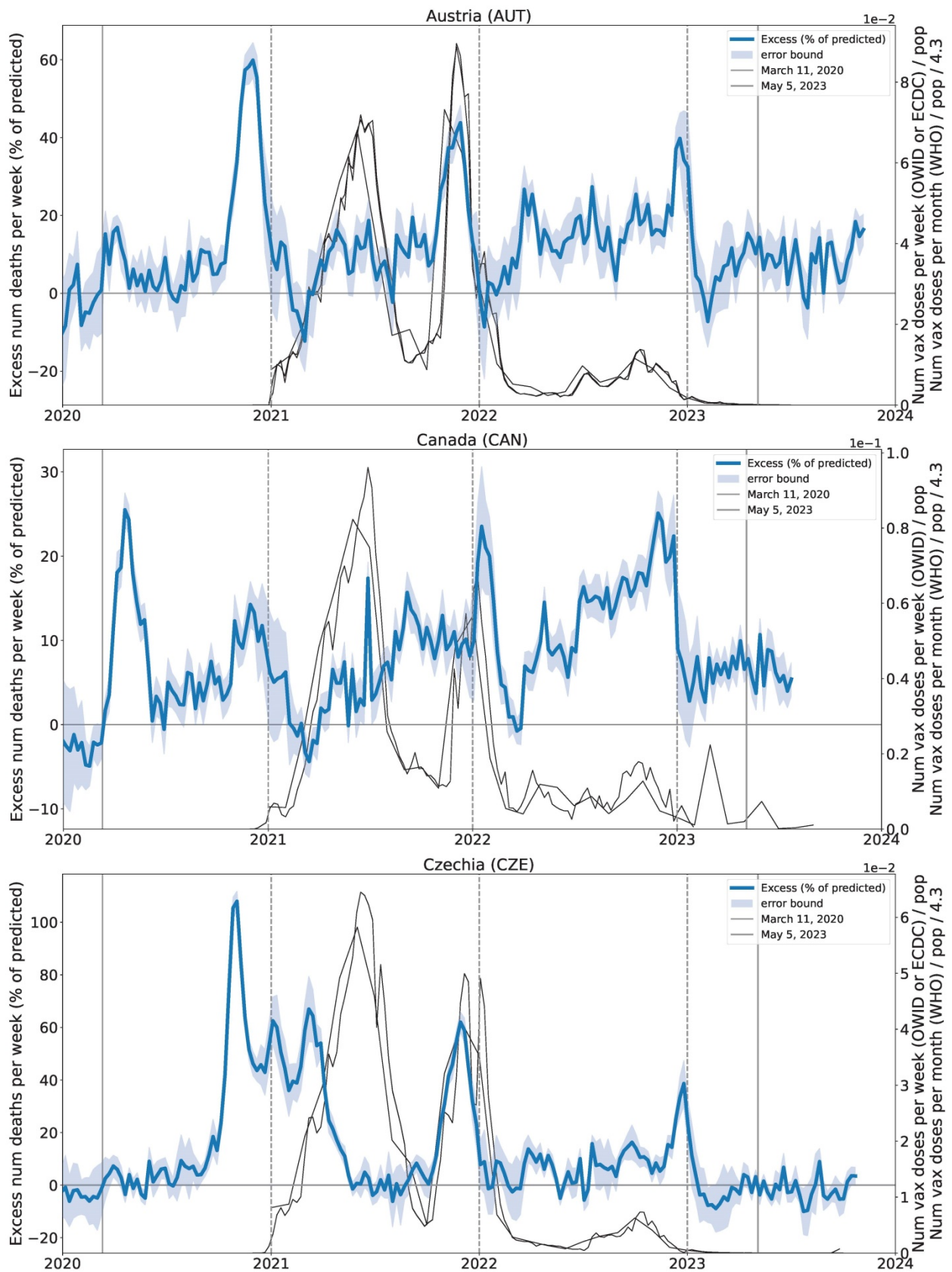
This pattern (Equation 3) captures 23 of the 87 countries with sufficient data: Austria, Belgium, Canada, Chile, Czechia, Denmark, Finland, France, Germany, Ireland, Japan, Latvia, Lithuania, Macao, Netherlands, Norway, Poland, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom, and USA, including many of the most vaccinated countries in the world.

An associated pattern is of the same shape as the pattern of Equation 3, but of lesser magnitude:

$$23-0 : 23-6 = \text{near-absent (or moderate)} : \text{absent (or near-absent)} \quad (4)$$

This pattern (Equation 4) captures 15 of the 87 countries with sufficient data: Australia, Chile, Croatia, Ecuador, Estonia, Hong Kong, Hungary, Iceland, Italy, Luxembourg, Mexico, Portugal, Russia, South Korea, and Spain.

In these 38 (23 + 15) of 87 countries, the prominent or near-absent 23-0 excess all-cause mortality peak drops suddenly in a step-wise manner to smaller (near-absent or absent) values at the end of 2022 and very start of 2023, moving into 2023 (**Appendix B**). This is illustrated for six countries in Figure 5.



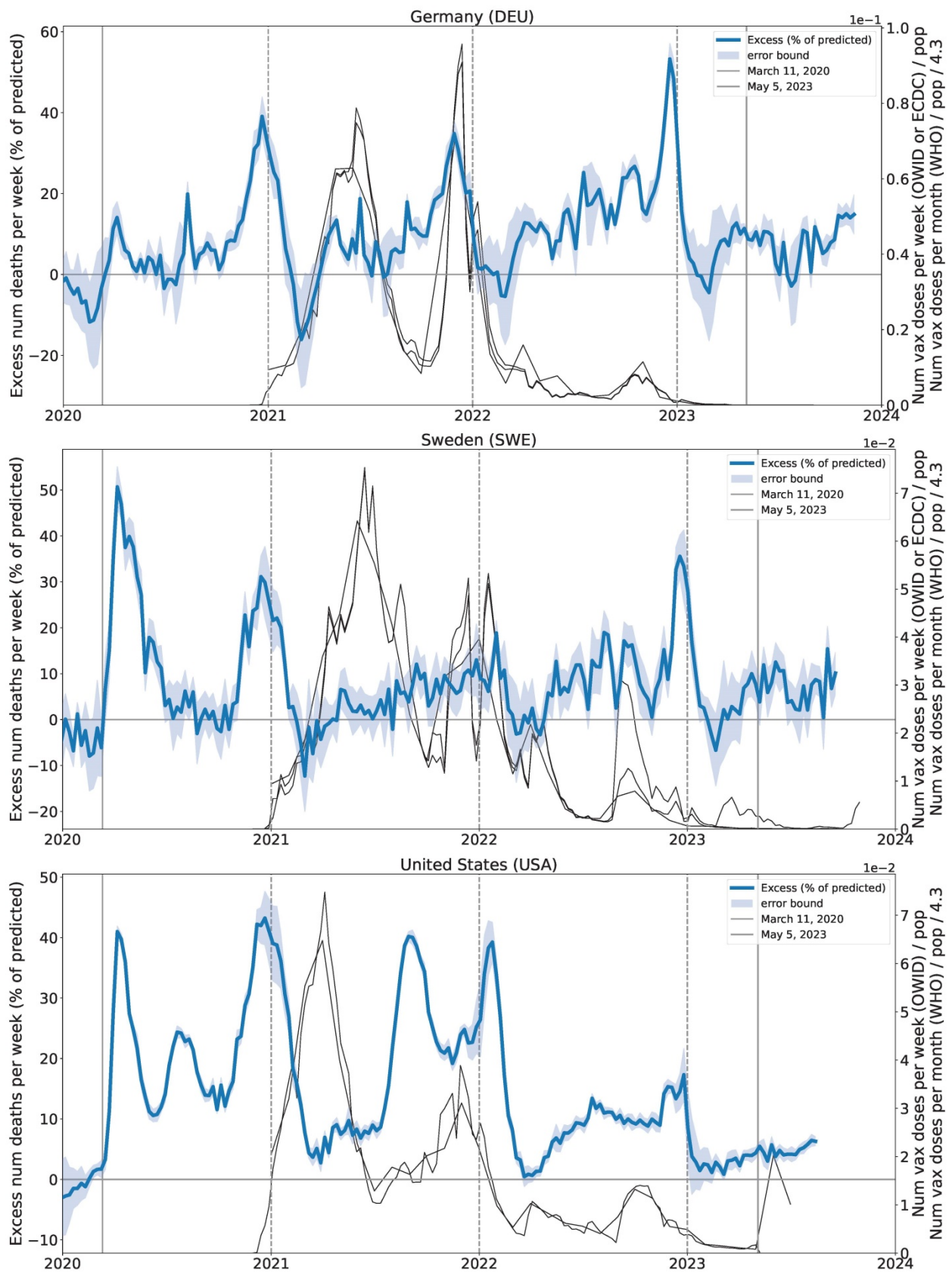


Figure 5. Excess all-cause mortality by week, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by week (“P-score”), with 1σ error bound shading, 2020-2023, for six select countries exhibiting the “23-0:23-6” feature described in the text (as per the panel labels): Austria, Canada, Czechia, Germany, Sweden, and USA. The vaccine rollout data from different sources by week is also shown (thin black lines).

We note that the 23-0 mortality peaks in the 38 (23 + 15) of 87 countries discussed above are preceded by and thus temporally associated with synchronous apparently booster rollout peaks (**Appendix B**).

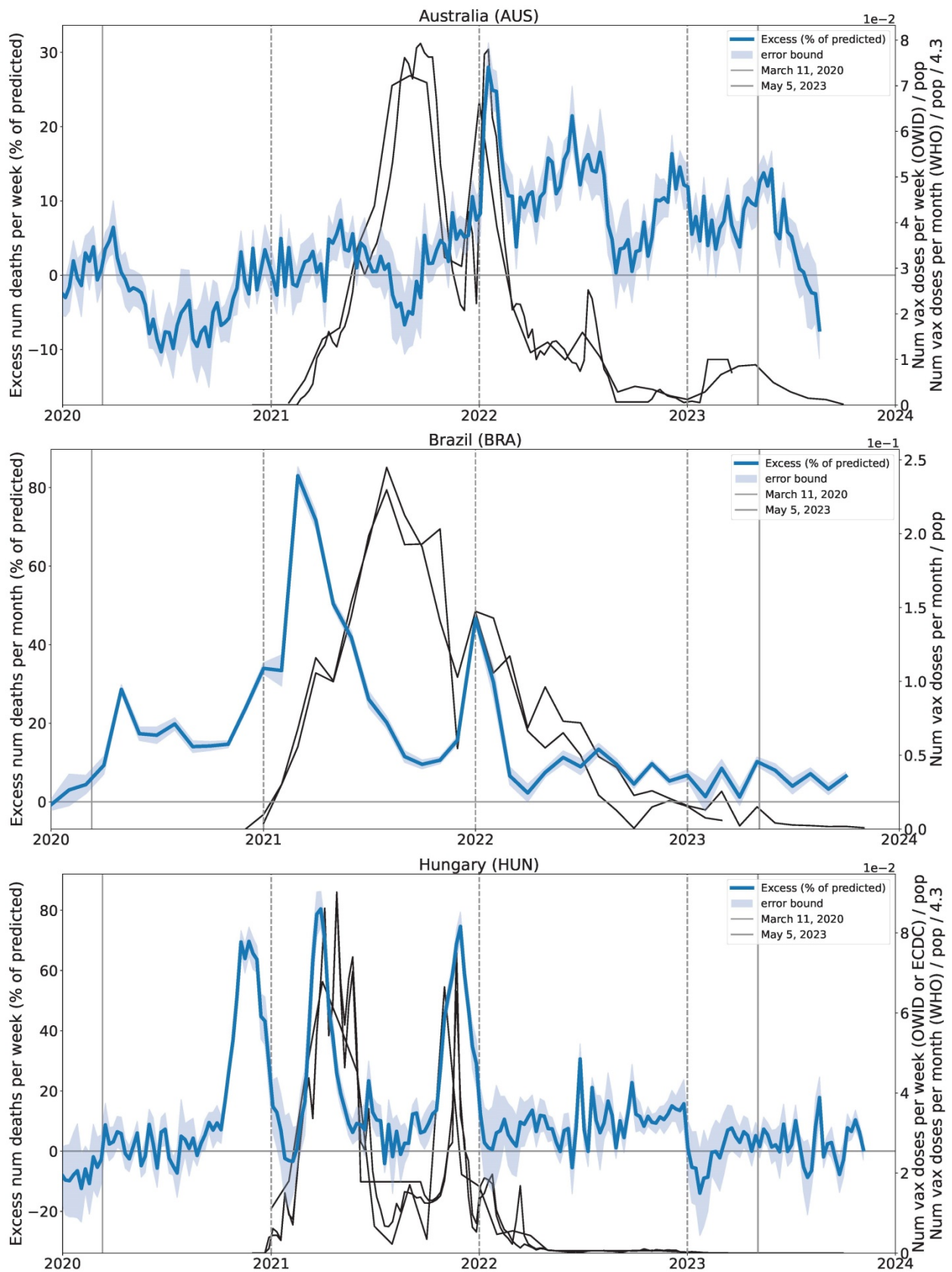
4.5 2021 December excess mortality peak (22-0 feature)

Similarly, a common 22-0 prominent or statistically evident excess mortality peak occurs within one month or so of 1 January 2022 in 113 of the 121 countries having sufficient mortality data (4 countries have no data at the relevant dates). This nominally 22-0 peak in excess all-cause mortality is temporally associated with a synchronous or preceding increase in vaccine administration (**Appendix B**). These synchronous or preceding increases in vaccine administration, associated with the 22-0 excess mortality peaks, are most often apparently boosters, which were rolled out in unison around the world at those dates. Nominally 22-0 excess mortality peaks are pervasive, and occur both in the Northern Hemisphere winter and in the Southern Hemisphere summer (**Appendix B**).

The 113 countries in question, exhibiting nominally 22-0 excess mortality peaks, are (**Appendix B**): Albania, Andorra, Antigua and Barbuda (earlier peak), Argentina, Armenia, Aruba (earlier peak), Australia, Austria, Azerbaijan, Bahamas (earlier peak), Barbados, Belgium, Belize, Bermuda, Bolivia, Bosnia, Brazil, Brunei, Bulgaria, Cabo Verde (earlier peak), Canada, Chile, Colombia, Costa Rica, Croatia, Cuba (home-country vaccine), Cyprus, Czechia, Denmark, Dominican Republic, Ecuador, Egypt, Estonia, Faroe Islands, Finland, France, French Guiana, French Polynesia (earlier peak), Georgia, Germany, Gibraltar (first vaccine dose), Greece, Guadeloupe, Guatemala, Hong Kong, Hungary, Iceland, Iran, Israel, Jamaica (earlier peak), Japan, Jordan, Kazakhstan, Kosovo (no vaccine data), Kuwait, Latvia, Lebanon, Liechtenstein,

Lithuania, Luxembourg, Malaysia, Maldives, Malta, Martinique (earlier large peak, small peak, no vaccine data) , Mauritius, Mayotte (no vaccine data), Mexico, Moldova, Monaco, Mongolia, Montenegro, Namibia, Netherlands, New Caledonia (earlier large peak, small peak), Nicaragua (earlier peak, precedes main vaccination surge), North Macedonia, Norway, Oman, Palestine (earlier peak), Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Reunion, Romania, Russia, Saint Kitts and Nevis, Saint Vincent and the Grenadines (earlier peak), San Marino, Serbia, Seychelles, Singapore, Slovakia, Slovenia, South Africa, South Korea, Suriname, Sweden, Switzerland, Taiwan (later peak), Tajikistan (earlier peak, first dose rollout), Thailand, Transnistria (no vaccine data), Tunisia, Turkey, Ukraine, United Arab Emirates (earlier peak), USA, Uruguay, and Uzbekistan (earlier and later peaks).

The excess mortality and vaccine administration data for five select examples of these 113 countries (Australia, Brazil, Hungary, Mexico, Slovakia) are shown in Figure 6. Six more examples of the 113 countries (Austria, Canada, Czechia, Germany, Sweden, USA) exhibiting a nominally 22-0 excess mortality peak are shown in Figure 5. Here, Sweden is a rare limiting case in which the nominally 22-0 excess mortality peak is not so pronounced as a distinctive peak.



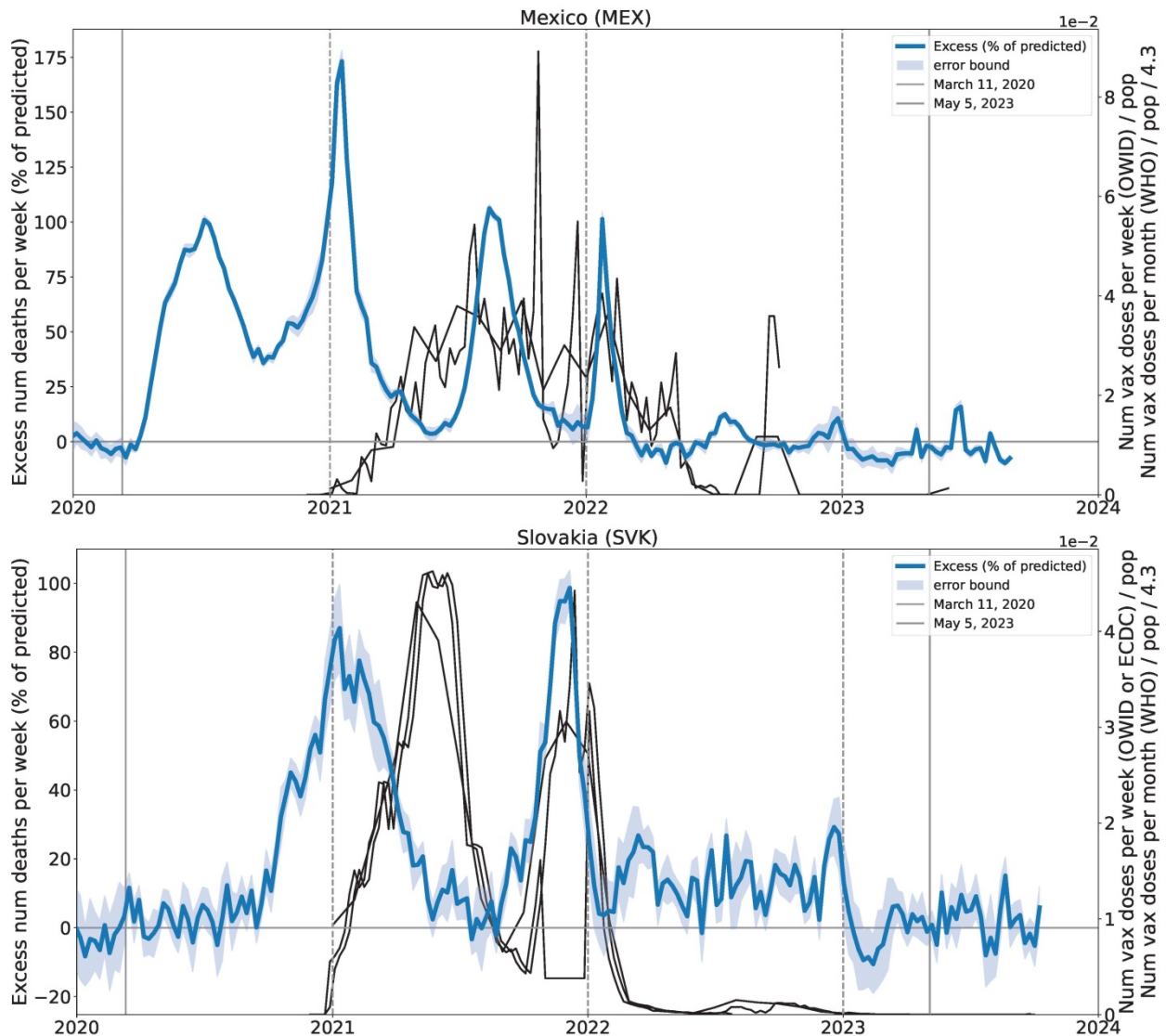


Figure 6. Excess all-cause mortality by week or month, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by week or month (“P-score”), with 1σ error bound shading, 2020-2023, for five select countries exhibiting the “22-0” feature described in the text (as per the panel labels, top to bottom): Australia, Brazil, Hungary, Mexico, and Slovakia. The vaccine rollout data from different sources by week is also shown (thin black lines).

Somewhat related to the case of Sweden, 8 of the 121 countries with sufficient mortality data have no definitive or detected nominally 22-0 excess all-cause mortality peak (**Appendix B**): Greenland (no measurable excess mortality at any time in the Covid period), Ireland, Italy, Kyrgyzstan, Macao, New Zealand, Spain, and United Kingdom. Among these — like the case of Sweden — Ireland, Italy, Spain and UK have relatively

large 20-3 (2020 March-April) excess mortality peaks (comparatively massive in Spain) and relatively large near-21-0 (2020 December, 2021 January) excess mortality peaks. Also, Italy has an unusual sharp and large 2022 mid-summer (22-6) excess mortality peak, and Ireland (like Sweden) has a relatively large 23-0 peak (**Appendix B**).

4.6 Large sudden all-cause mortality peaks in island nations

Sixteen island states and four small coastal countries in the present study have unusual all-cause mortality by time (week or month) behaviours exhibiting zero or relatively small excess mortality at all times in the Covid period with available data, except for a single dominant and sharp peak (**Appendix A, Appendix B**).

The sixteen island countries in question are: Antigua and Barbuda (Caribbean Sea), Bahamas (Caribbean Sea), Barbados (Caribbean Sea), Bermuda (Atlantic Ocean, north of Caribbean Sea), Cuba (Caribbean Sea), French Polynesia (Pacific Ocean), Guadeloupe (Caribbean Sea), Jamaica (Caribbean Sea), Maldives (Indian Ocean), Martinique (Caribbean Sea), Mauritius (Indian Ocean), Mayotte (Indian Ocean), New Caledonia (Pacific Ocean), Reunion (Indian Ocean), Saint Vincent and the Grenadines (Caribbean Sea), and Taiwan (East China Sea, South China Sea)

The four small coastal (or largely coastal) states in question are: Brunei (border with Malaysia), Hong Kong (city-state, special administrative region of China), Macao (city-state, special administrative region of China), and South Korea (Sea of Japan, East China Sea, border with North Korea).

The two Pacific Ocean island countries, French Polynesia and New Caledonia, have sudden columnar peaks in monthly all-cause mortality in August-September 2021 and September-October 2021, respectively. Each said columnar peak in mortality coincides exactly with a large burst in vaccines injections administered in the same months. This is shown in Figure 7.

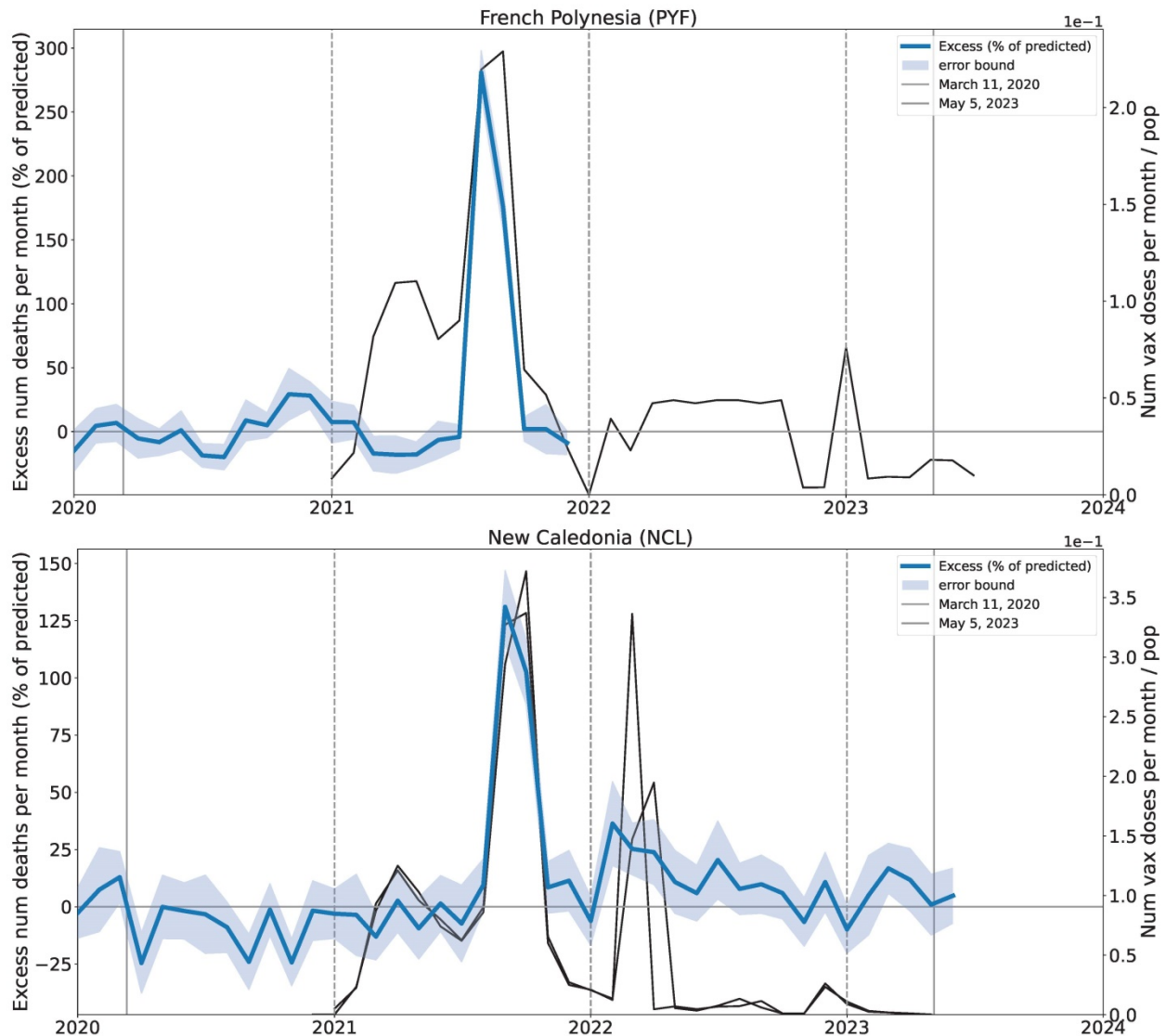
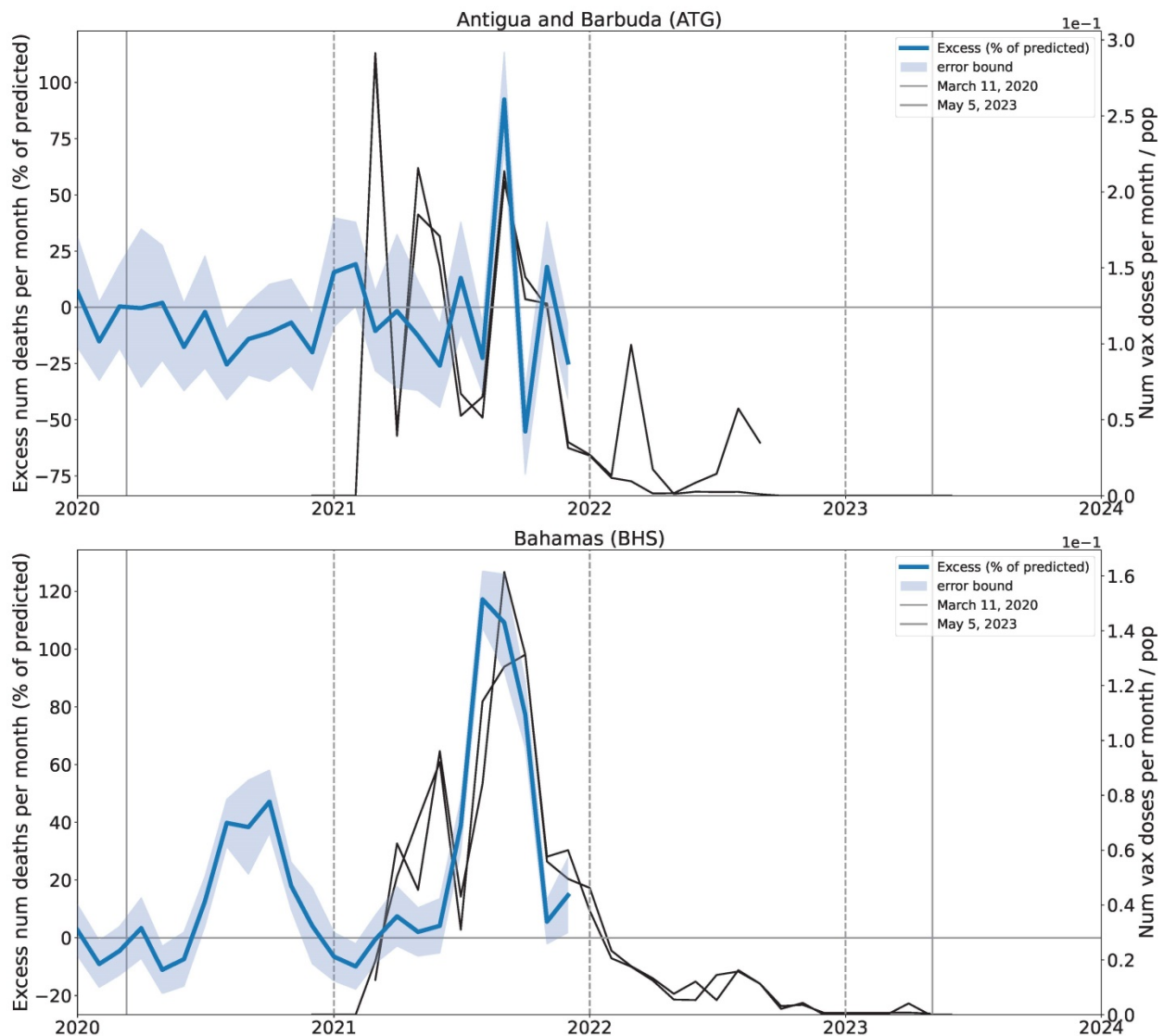
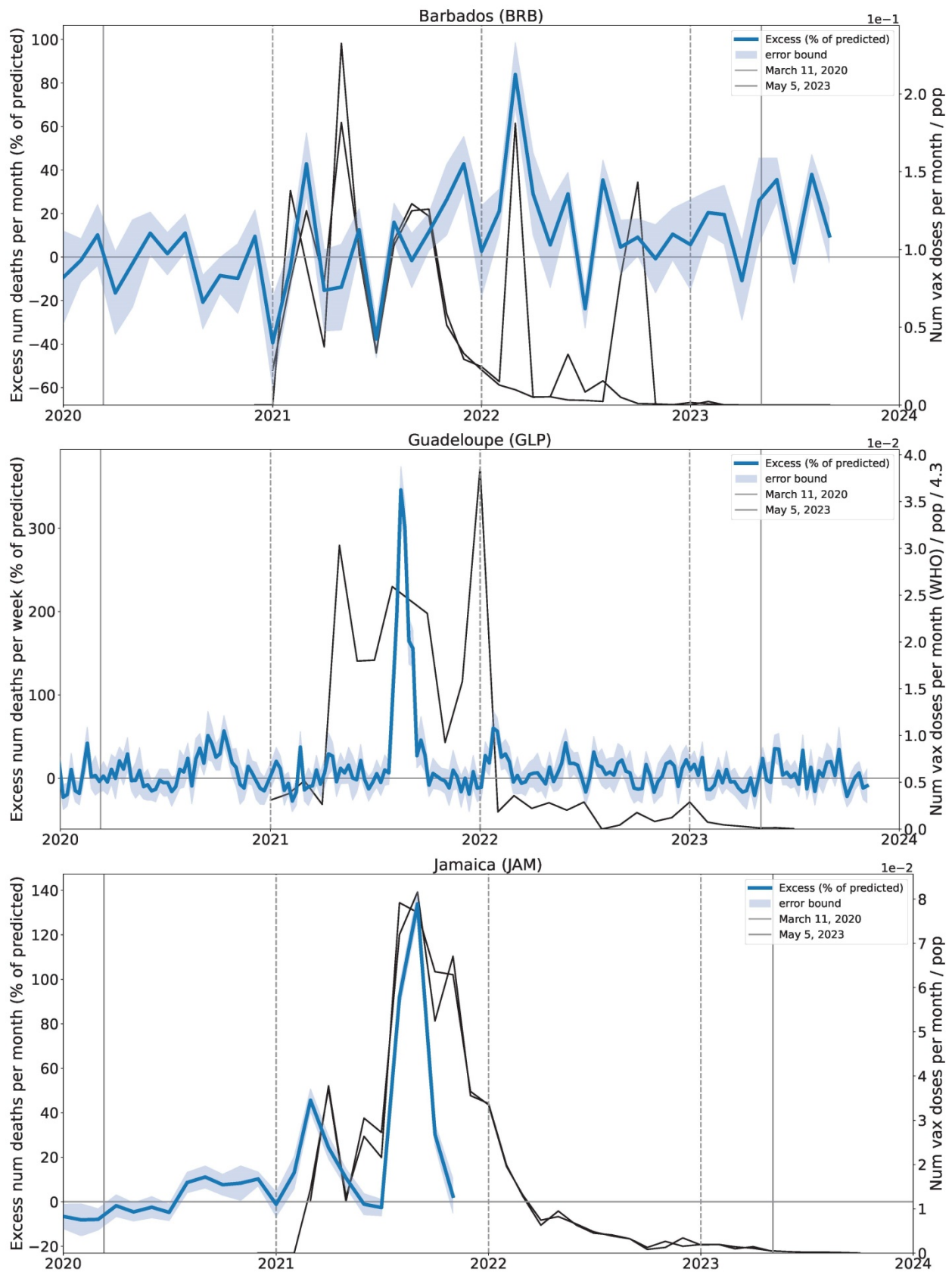


Figure 7. Excess all-cause mortality by month, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by month (“P-score”) (blue), with 1σ error bound shading, and vaccine rollout data from different sources by month (thin black lines), 2020-2023, for the two Pacific Ocean island nations, French Polynesia and New Caledonia.

A similar behaviour is seen in the seven Caribbean island countries: Antigua and Barbuda, Bahamas, Barbados, Guadeloupe, Jamaica, Martinique, and Saint Vincent and the Grenadines. This is shown in Figure 8. The behaviour also occurs in Cuba (see below).

Here, the columnar 2-month peaks in mortality always occur in July through October 2021, and are generally temporally associated with known vaccine rollout bursts, except that the peak in mortality in Barbados occurs in March 2022 and is associated with a fourth-dose vaccine rollout, and vaccination data was not available for Martinique.





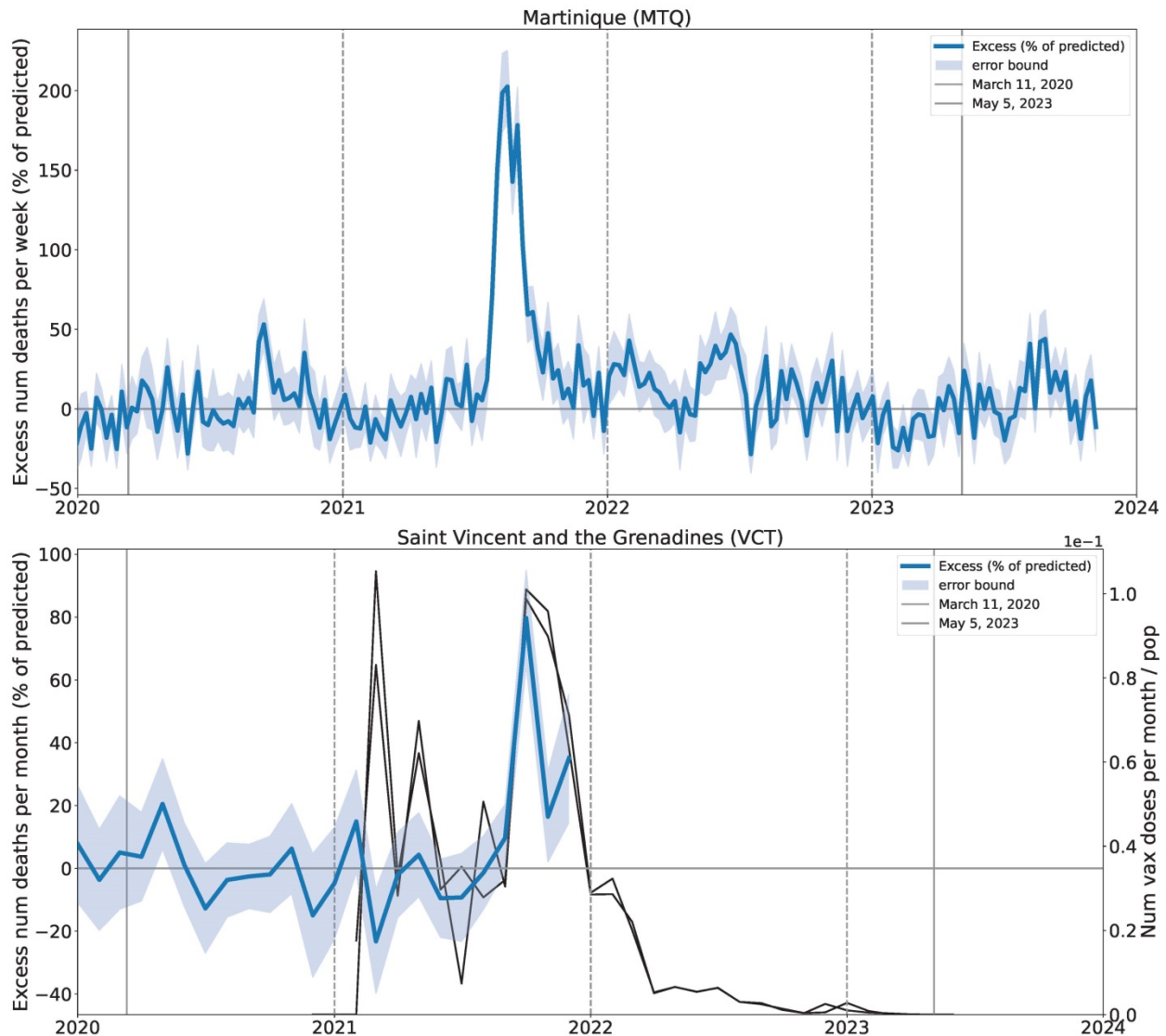


Figure 8. Excess all-cause mortality by week or by month, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by week or by month (“P-score”) (blue), with 1σ error bound shading, and available vaccine rollout data from different sources by month (thin black lines), 2020-2023, for the seven Caribbean island countries, Antigua and Barbuda, Bahamas, Barbados, Guadeloupe, Jamaica, Martinique, and Saint Vincent and the Grenadines.

Bernuda, which is in the Atlantic Ocean more than 1,000 km north of the Caribbean Sea, also shows a columnar mortality peak in September 2021, but which follows a large vaccination rollout period rather than being synchronous with it. Back to the Caribbean Sea, Cuba also has a large columnar mortality peak in August-September

2021, which is essentially synchronous with the rapid rollout of its own manufactured vaccine. The cases of Bermuda and Cuba are shown in Figure 9.

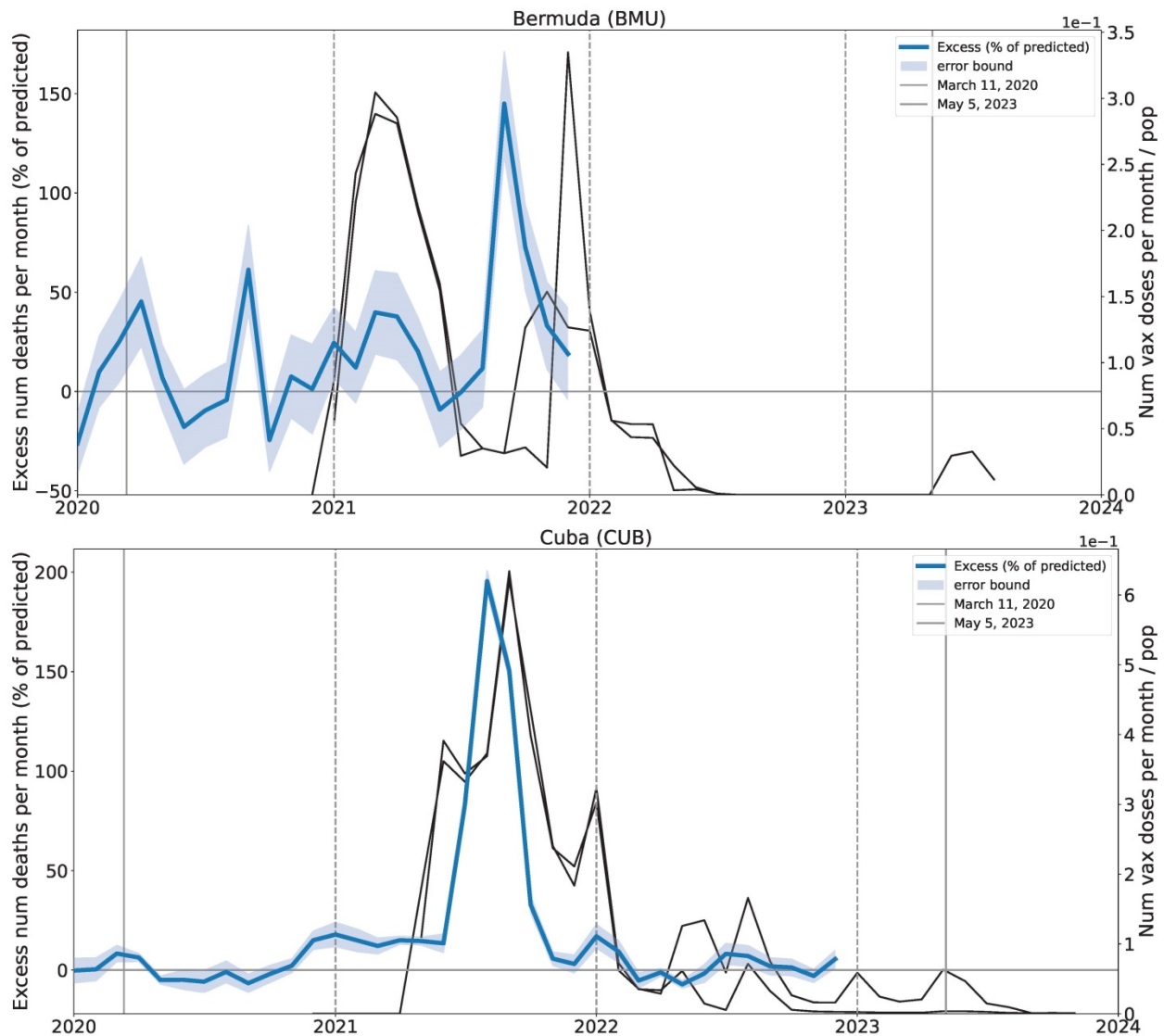
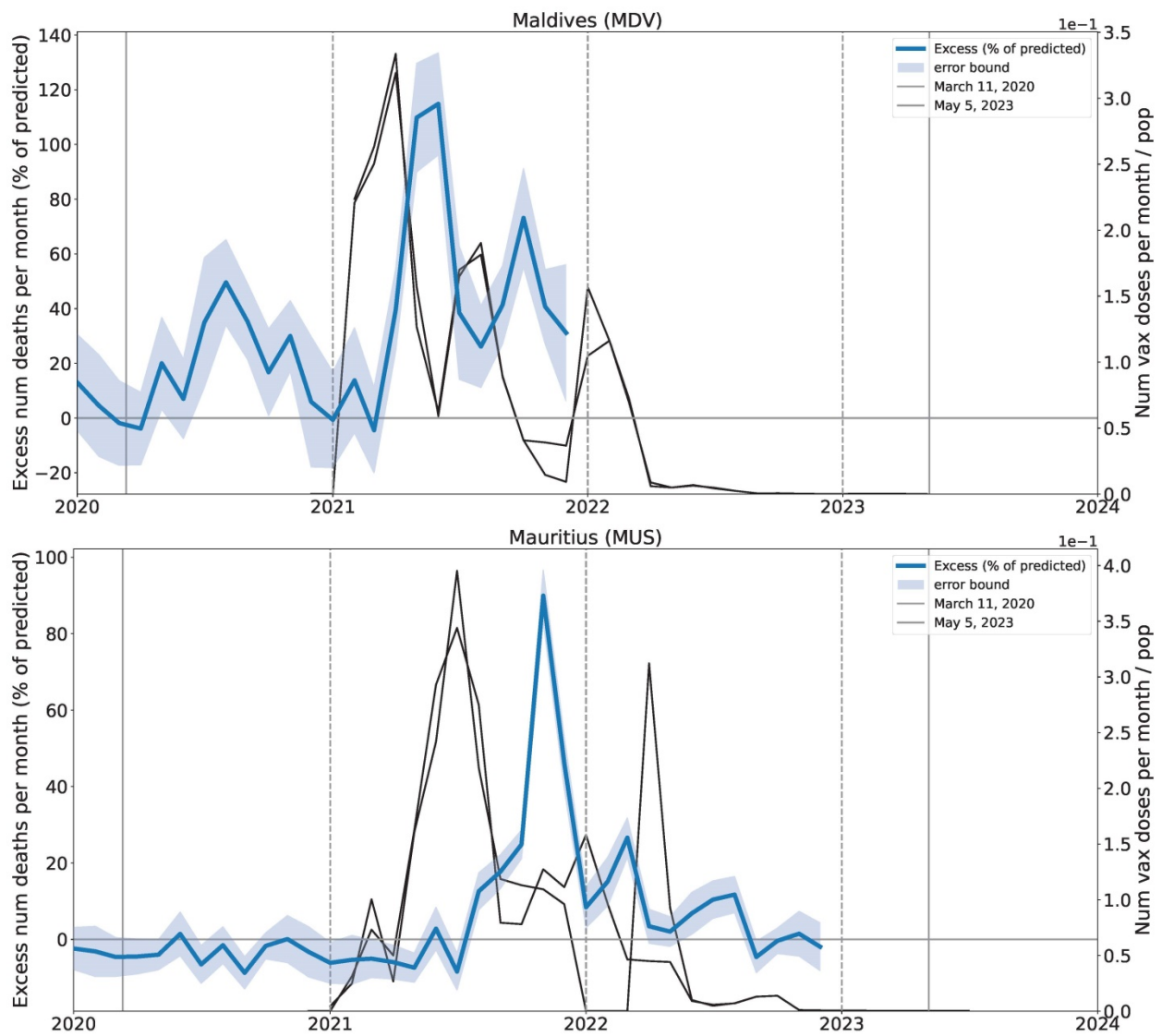


Figure 9. Excess all-cause mortality by month, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by month (“P-score”) (blue), with 1σ error bound shading, and available vaccine rollout data from different sources by month (thin black lines), 2020-2023, for Bermuda and Cuba.

The dates (in 2021 and 2022) of the columnar mortality peaks are more variable in the island countries of the Indian Ocean in the present study: Maldives, Mauritius, Mayotte, and Reunion. These cases are shown in Figure 10. The case of Maldives is suggestive of an association between preceding vaccine rollouts and peaks in all-cause mortality.



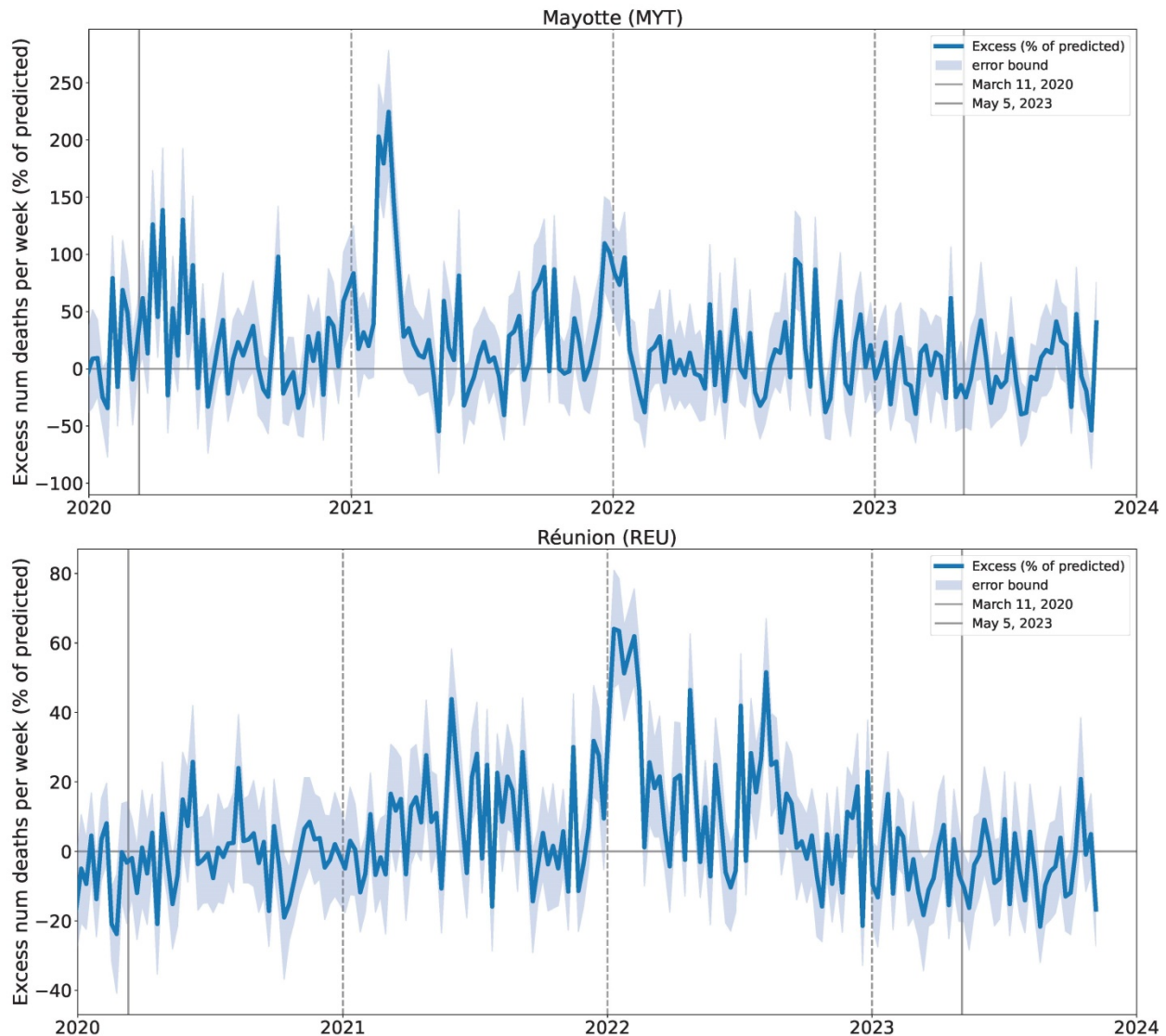
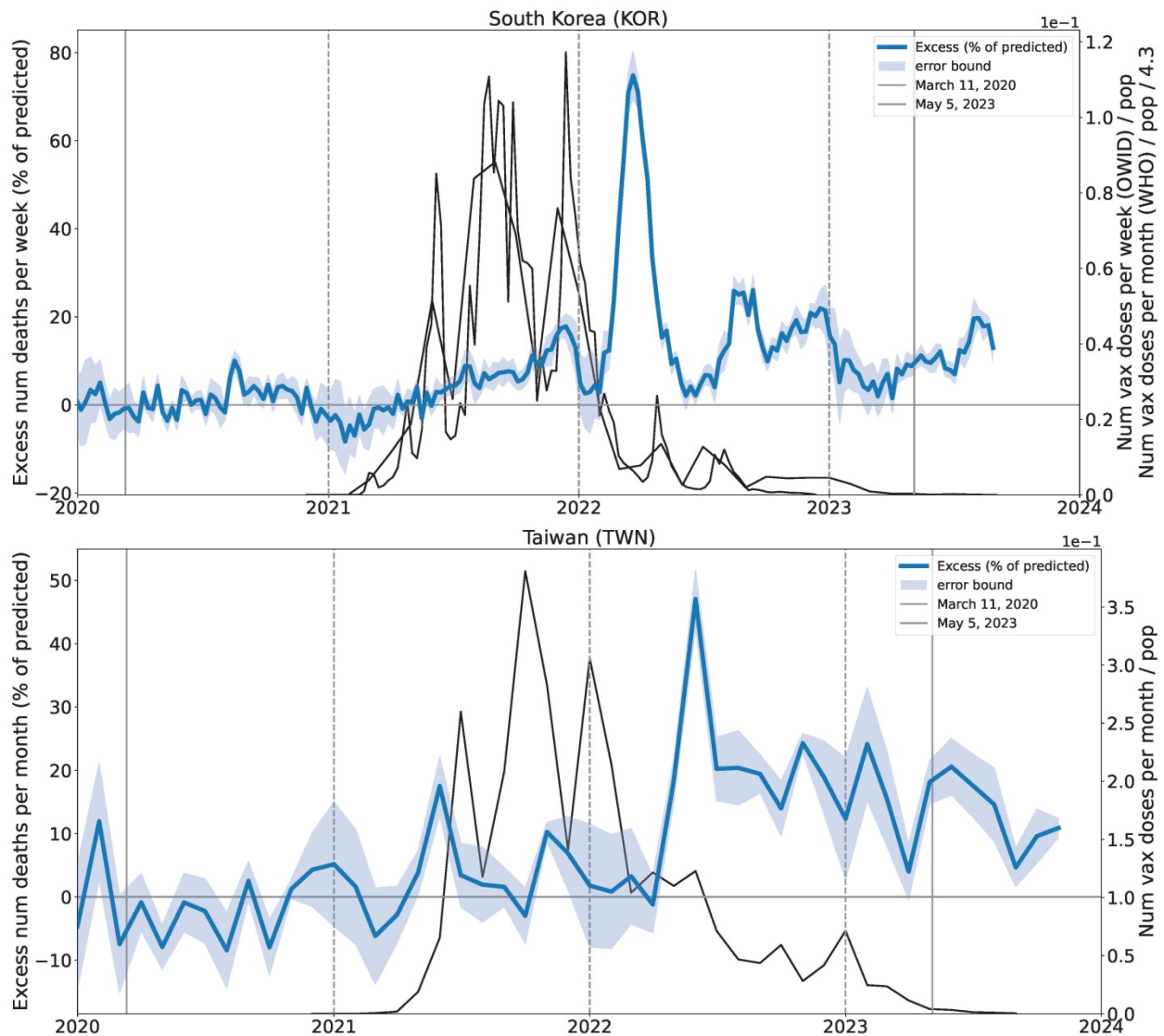


Figure 10. Excess all-cause mortality by week or by month, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by week or by month (“P-score”) (blue), with 1 σ error bound shading, and available vaccine rollout data from different sources by month (thin black lines), 2020-2023, for four island countries in the Indian Ocean, Maldives, Mauritius, Mayotte, and Reunion.

The coastal country of South Korea and the large island of Taiwan both have their dominant columnar mortality peaks in early 2022, following the bulk of vaccine rollouts in these countries. Two coastal city special administrative regions of China, Hong Kong and Macao, have their dominant columnar mortality peaks in 2022, also following the bulk of vaccine rollouts in these countries, but temporally associated (immediately

following and synchronous with) late-dose or booster-dose vaccine rollouts. These cases of South Korea, Taiwan, Hong Kong, and Macao are shown in Figure 11.



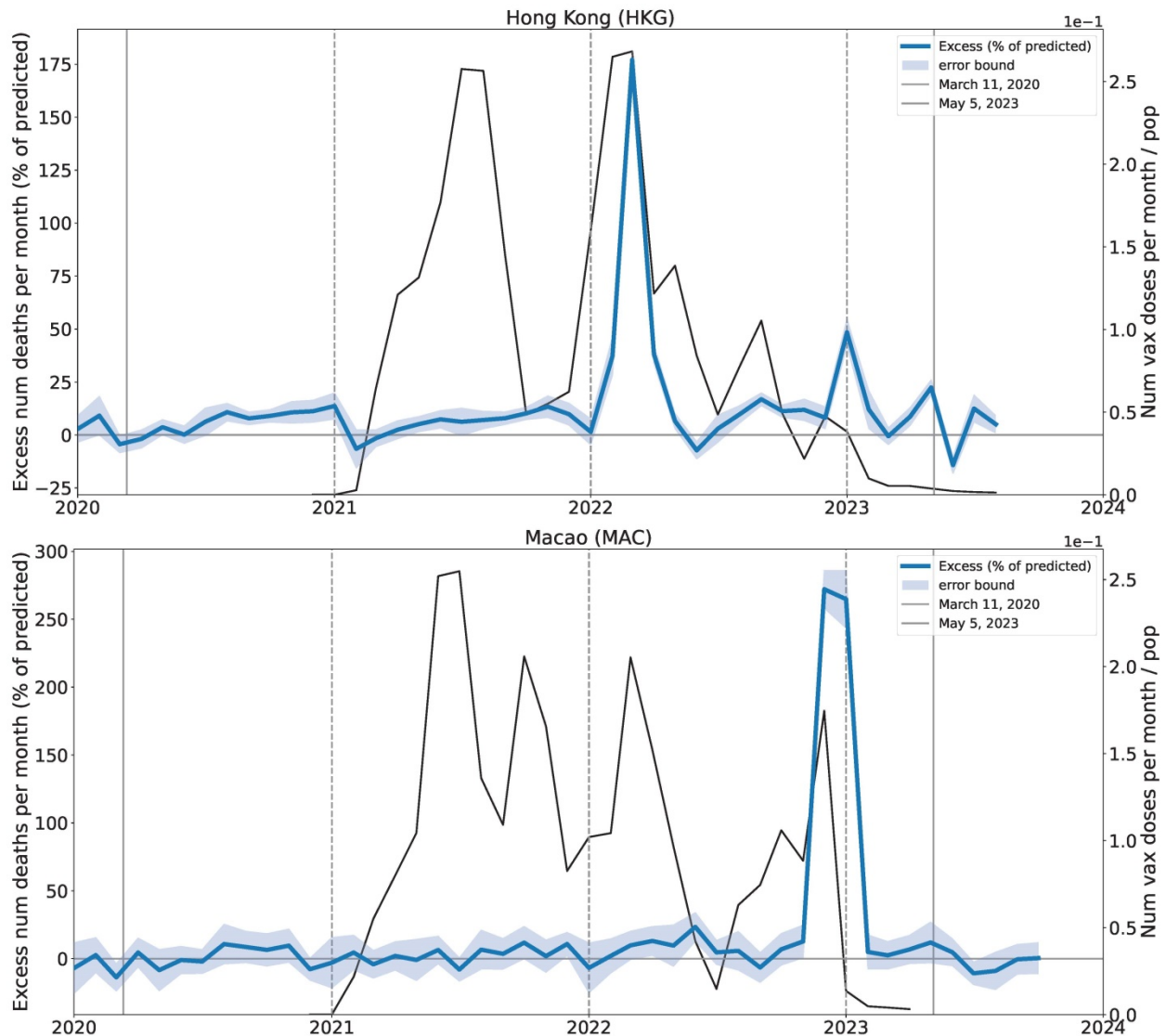


Figure 11. Excess all-cause mortality by week or by month, expressed as a percentage of the predicted (extrapolated historic trend) all-cause mortality by week or by month (“P-score”) (blue), with 1σ error bound shading, and available vaccine rollout data from different sources by week or by month (thin black lines), 2020-2023, for South Korea, Taiwan, Hong Kong, and Macao.

4.7 Cluster analysis of Covid-period geo-temporal patterns of all-cause mortality in the world

In addition to the many specific features described in the above subsections, a cluster analysis immediately discerns distinct categories of coarse-grain features of mortality by time data, on continental and sub-continental scales, for example, as follows.

Simply using the time series of raw all-cause mortality integrated over the calendar years 2019, 2020, 2021 and 2022 (4-point time series), three clusters immediately emerge, without any adjustable parameters (see Methods), as shown in Figure 12.

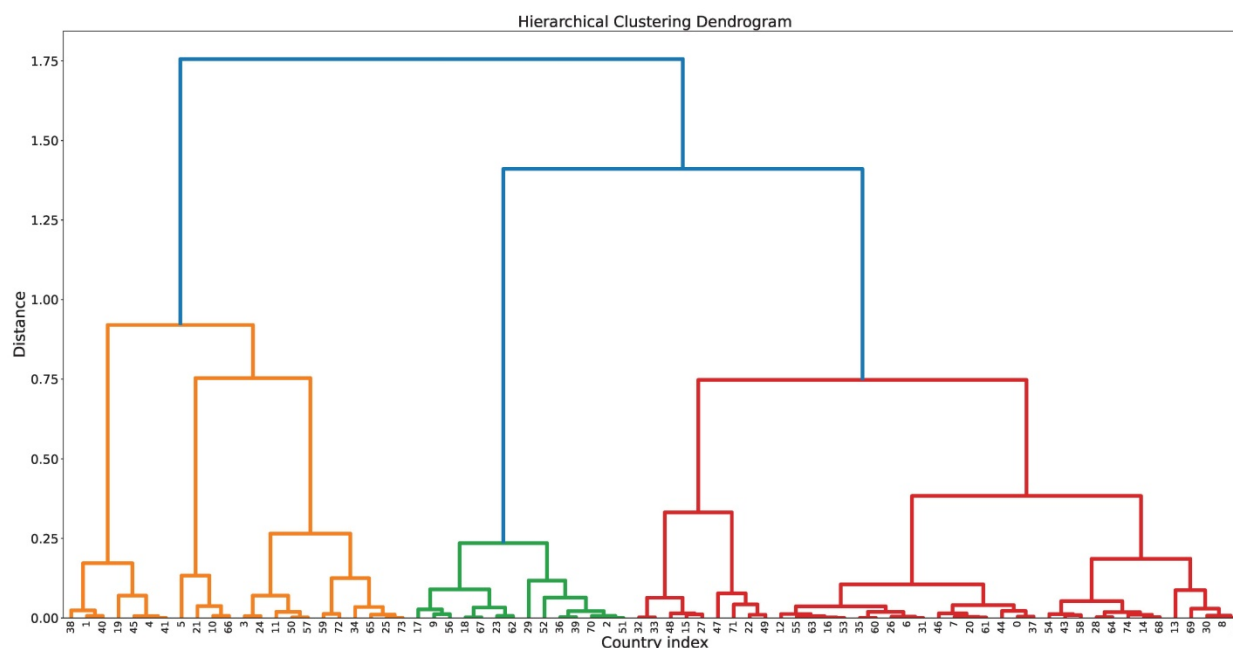


Figure 12. Hierarchical clustering dendrogram result using the 4-point time series of integrated all-cause mortality for the calendar years 2019, 2020, 2021 and 2022, for all countries with sufficient data. The three highest level clusters are coloured orange, green and red, for easy reference.

Here, 75 of the 125 countries have sufficient data (through 2022) and 2019 populations more than 1 million, and divide into the three highest level clusters as follows:

- **ORANGE** (22 countries): Armenia, Austria, Azerbaijan, Belgium, Chile, Ecuador, France, Italy, Kosovo, Kuwait, Kyrgyzstan, Mexico, Netherlands, Portugal, Qatar, Slovenia, Spain, Sweden, Switzerland, United Kingdom, USA, Uzbekistan
- **GREEN** (14 countries): Australia, Canada, Denmark, Finland, Germany, Hong Kong, Japan, New Zealand, Norway, Puerto Rico, Singapore, South Korea, Taiwan, Thailand
- **RED** (39 countries): Albania, Bosnia, Brazil, Bulgaria, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czechia, Egypt, Estonia, Georgia, Greece, Guatemala,

Hungary, Ireland, Israel, Jordan, Kazakhstan, Latvia, Lithuania, Malaysia, Mauritius, Moldova, Mongolia, North Macedonia, Oman, Paraguay, Philippines, Poland, Romania, Russia, Serbia, Slovakia, South Africa, Tunisia, Turkey, Uruguay

These three main clusters are shown on a world map in Figure 13.

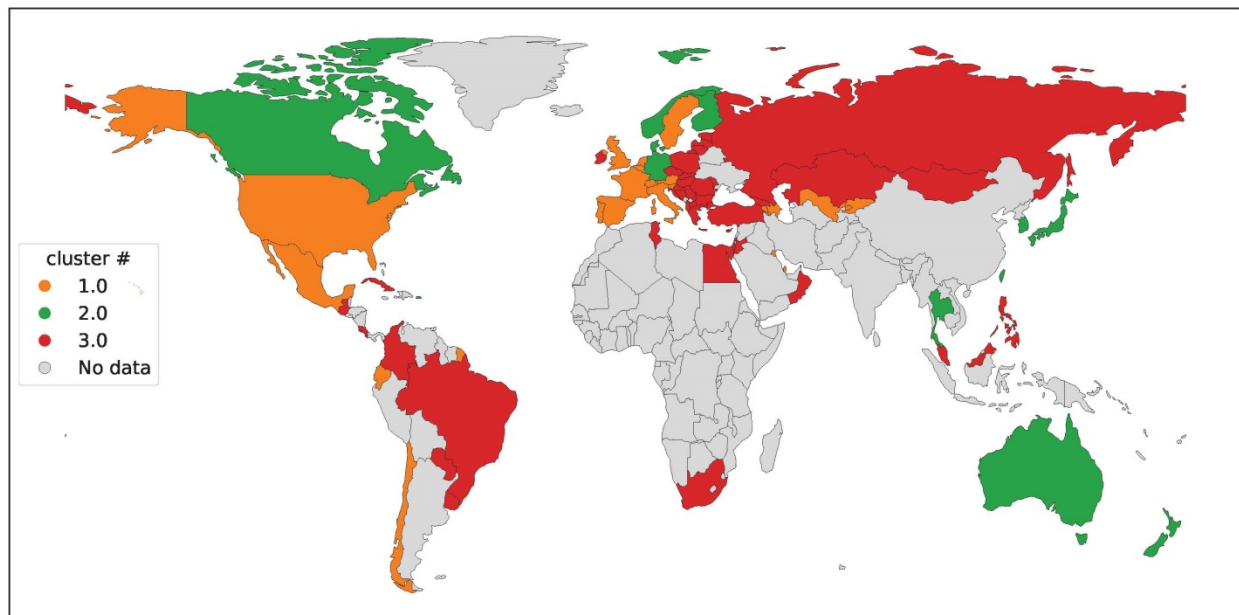


Figure 13. World map of the three (orange, green and red) highest level clusters of countries, from the cluster analysis described in the text.

Note that the strong East-West divide highlighted in the above analysis of the 20-10 peak in excess all-cause mortality is captured in the cluster analysis, as an orange-cluster/red-cluster divide (Figure 13).

Also note that the green-cluster (14 countries) is almost entirely populated by countries that have certain persistent excess all-cause mortality in 2023 (29 countries described above), except Hong Kong (borderline excess mortality in 2023) and New Zealand, which is 12 of 29 countries, even though the time series input into the cluster analysis does not include 2023. The said 12 of 29 countries are essentially those in the 29

countries that have small or zero excess mortality in the first year or more of the declared pandemic.

4.8 Persistent excess all-cause mortality in 2023

Generally, in the majority of cases, excess all-cause mortality decreases to relatively small values — compared to large values at times in the Covid period — virtually immediately in January 2023, up to and beyond the 5 May 2023 WHO announcement of an end to a declared pandemic (**Appendix A, Appendix B**).

Seventy nine (79) of the 125 countries in the present study have all-cause mortality data up to or beyond March 2023, which allows an evaluation of excess mortality into 2023. Seventy six (76) of the 125 countries in the present study have all-cause mortality data up to at least 30 June 2023, which allows reliable quantification of excess mortality into 2023. The magnitude and statistical reliability of inferred excess all-cause mortality into 2023 is best assessed using the analysis on the mortality by time data itself, illustrated in the figure of **Appendix A**.

Of the 76 countries allowing reliable quantification, 32 countries have a high statistical certainty of having persistent and significant excess all-cause mortality in the available data for 2023, excluding excess mortality from peak residuals extending out from 2022 (by selecting an integration start date a few weeks or more later than 1 January 2023).

The quantification result is shown — for the integration period 2023-01-16 to 2023-06-30 (weekly data) or 2023-02-01 to 2023-06-30 (monthly data) (the 2023-H1* period) — in Figure 14, which is interpreted in conjunction with the figure in **Appendix A**.

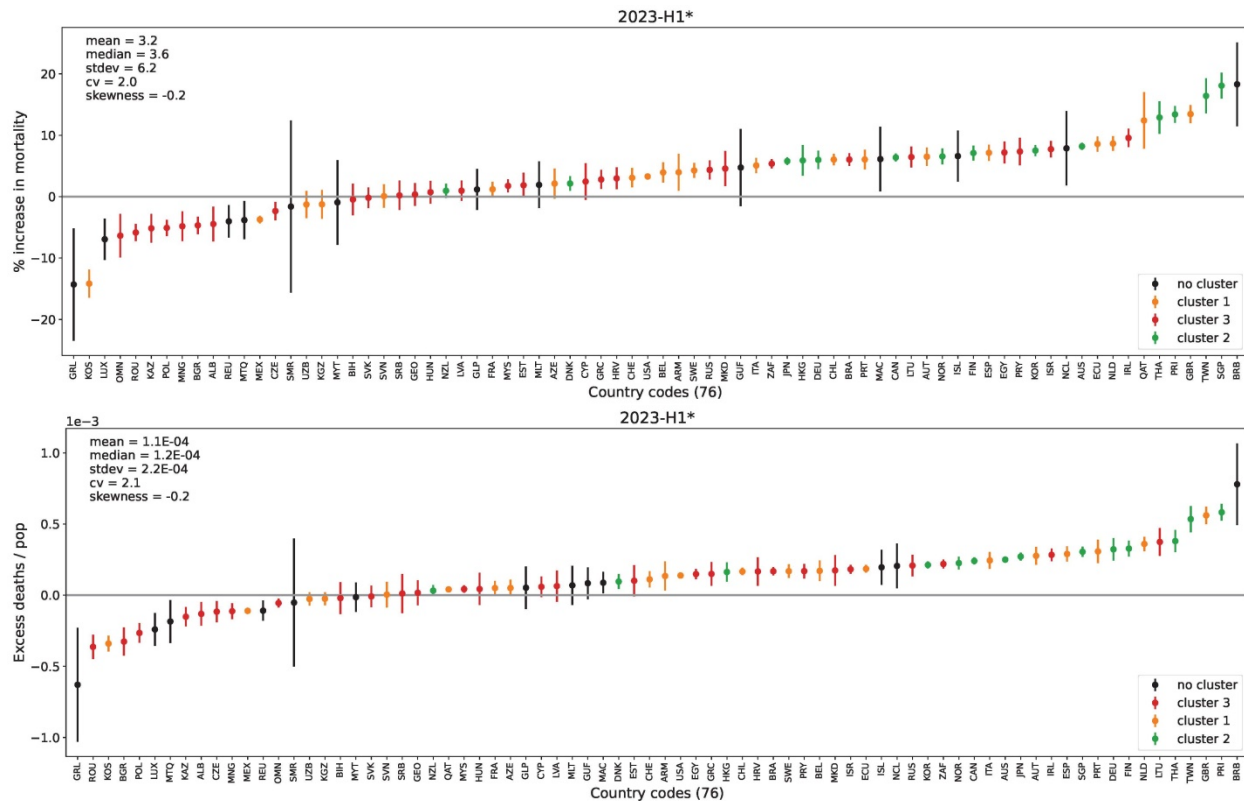


Figure 14. Excess all-cause mortality for the period 2023-01-16 to 2023-06-30 (weekly data) or 2023-02-01 to 2023-06-30 (monthly data) (the 2023-H1* period), expressed as a percentage of the predicted mortality for the same period (upper panel) or as a fraction of the 2019 population (lower panel), with 1σ error bars, by country (as labelled). The colours correspond to the three clusters from the cluster analysis. Each panel shows the values of the mean, median, standard deviation, coefficient of variation (standard deviation / mean), and skewness (Fisher-Pearson coefficient of skewness).

Therefore, the 32 countries having a high statistical certainty of persistent and significant excess all-cause mortality into 2023, compared to the extrapolated pre-Covid historic trend (**Appendix A**), excluding excess all-cause mortality from peak residuals extending out from 2022, and excluding accidentally large values, are: Australia, Austria, Belgium, Brazil, Canada, Denmark, Ecuador, Egypt, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Lithuania, Netherlands, Norway, Portugal, Puerto Rico, Qatar, Russia, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, and USA. Of these 32 countries, the four that are most borderline (subjectively least certain) would be France, Hong Kong, Russia and Switzerland.

The corresponding values of reliable persistent excess all-cause into 2023 for the 32 countries in question typically are in the range 5-15% of expected historical baseline mortality, or $(2-20 \times 10^{-4})$ % of 2019 population per week (Figure 14).

The three examples (from **Appendix A**) of Canada, Ireland and Netherlands are shown in Figure 15.

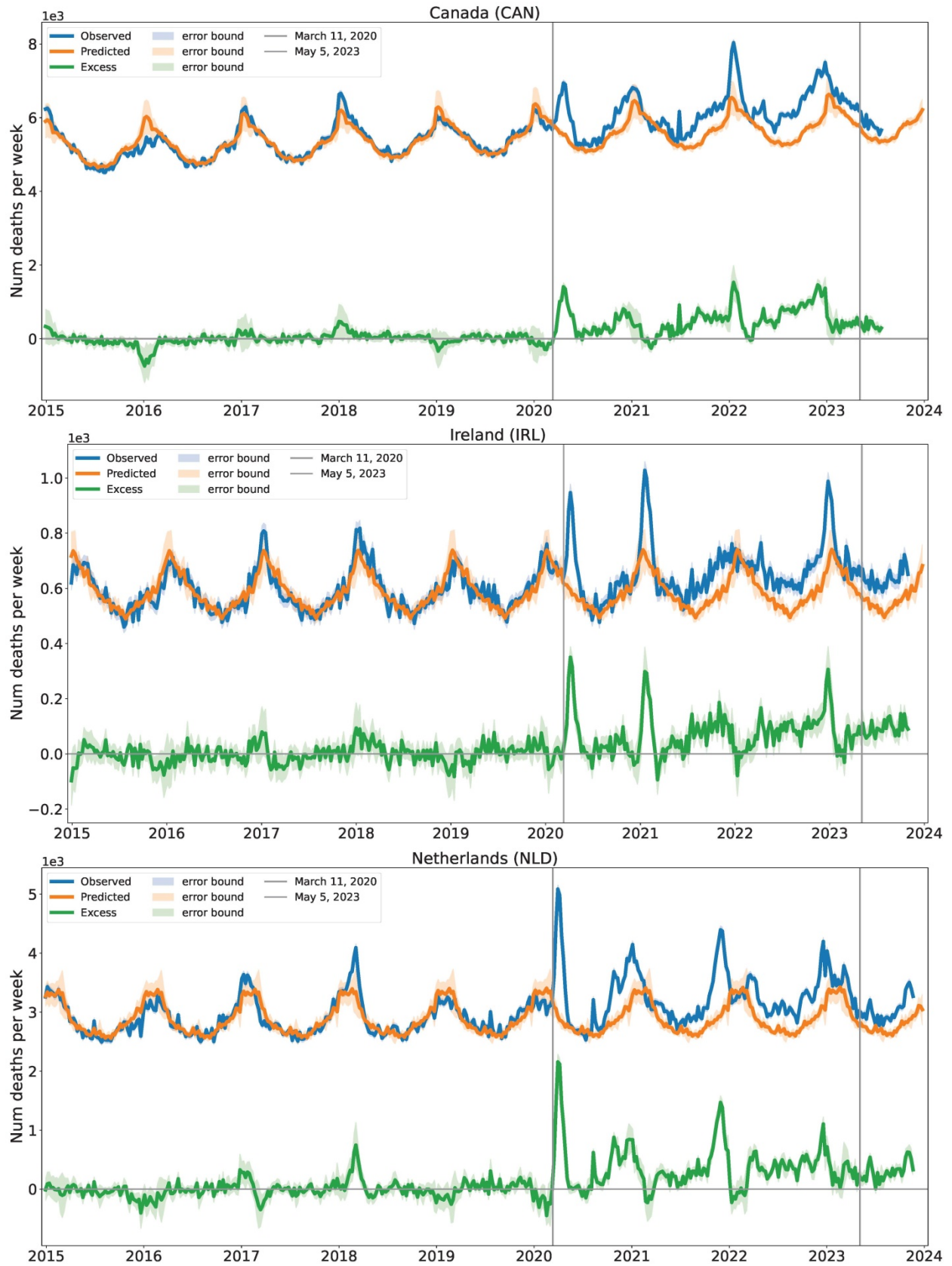


Figure 15. All-cause mortality by week (bleu) and historic trend all-cause mortality by week (orange) (top curves) and excess all-cause mortality by week (bottom curves), with 1σ error bounds, 2015-2023, for Canada, Ireland and Netherlands, from Appendix A. The vertical grey lines indicate the dates of 11 March 2020 (declared start of a pandemic) and 5 May 2023 (declared end of the declared pandemic).

The other 44 of 76 countries show near zero or negative excess all-cause mortality into 2023, and no statistically reliable positive value (Figure 14 and **Appendix A**). This means that 58% of the countries with sufficient data in the present study returned to normal or non-excess all-cause mortality in 2023. Three countries with less data appear to also have normal mortality, at least at the start of 2023. These 3 countries are Montenegro, Philippines and Uruguay (**Appendix A**).

The 44 of 76 countries showing near zero or negative excess all-cause mortality into 2023, or no statistically reliable positive value, are: Albania, Azerbaijan, Bosnia, Bulgaria, Czechia, Estonia, French Guiana, Georgia, Greece, Greenland, Guadeloupe, Hungary, Kazakhstan, Kosovo, Kyrgyzstan, Latvia, Luxembourg, Macao, Mayotte, Mexico, New Caledonia, New Zealand, Oman, Poland, Reunion, Romania, San Marino, Serbia, Slovakia, Slovenia, and South Africa (with high statistical certainty of being ≤ 0); and Armenia, Barbados, Chile, Croatia (with low statistical certainty of being ≥ 0), Cyprus, Iceland, Malaysia, Malta, Martinique, Mongolia, North Macedonia, Paraguay, and Uzbekistan (with low statistical certainty of being ≤ 0).

Here, Uzbekistan is a special case in which the all-cause mortality strikingly shows large excess mortality peaks systematically occurring in mid-summer 2020, 2021, 2022 and 2023.

Note that countries with high post-declared-pandemic excess all-cause mortality are generally Western countries whereas Eastern European countries, for example, generally have no measurable post-declared-pandemic excess all-cause mortality.

Of the group of 32 countries having significant excess mortalities into 2023, nine (9) had virtually no excess all-cause mortality for more than one year into the declared

pandemic, and had excesses occurring solely after the commencement or near-completion of COVID-19 vaccination. These 9 countries are: Australia, Denmark, Finland, Japan, Norway, Singapore, South Korea, Taiwan, and Thailand (**Appendix A, Appendix B**).

All nine of these countries are among the 14 countries of the green cluster (cluster 2) from the above cluster analysis. And, thirteen (13) of the 14 green-cluster (cluster 2) countries (Figure 12, Figure 13, Figure 14) are among the 32 countries having significant excess mortalities into 2023. The only exception is green-cluster New Zealand. The 13 green-cluster countries in question are: Australia, Canada, Denmark, Finland, Germany, Hong Kong, Japan, Norway, Puerto Rico, Singapore, South Korea, Taiwan, and Thailand.

4.9 Quantitative excess all-cause mortality by time period and by country during the Covid period

A summary of excess all-cause mortality (and rate and P-score) data for the Covid period (2020-2022) is given in the table in **Appendix C** which has:

- 93 countries with data up to the end of 2022, in decreasing order of population
- The country names and country-name codes
- National population for 2019, by country
- Total excess all-cause mortality for the years 2020-2022 ("X202122"), with associated error, by country, for the 93 countries with sufficiently complete data
- Total predicted mortality for the years 2020-2022 deduced from the pre-Covid historic trend ("H202122"), with associated error, by country, for the 93 countries with sufficiently complete data
- Total excess all-cause mortality for the years 2020-2022 ("X202122"), expressed as a percentage ("X/pop%") of national population in 2019, with associated error, by country, for the 93 countries with sufficiently complete data
- Total excess all-cause mortality for the years 2020-2022 ("X202122"), expressed as a percentage ("X/hist%") of the predicted mortality for the same period (2020-

2022) deduced from the pre-Covid historic trend (“H202122”), with associated error, by country, for the 93 countries with sufficiently complete data

Here, X202122 is essentially the excess all-cause mortality during the Covid period, excluding the dates 1 January 2023 through 5 May 2023 of the declared pandemic.

This excess all-cause mortality during the Covid period (X202122), expressed as a percentage of the national population in 2019, has a broad range of values such as (rank-country, percentage, 1σ error in parenthesis): 1-Bulgaria, 1.11(0.03)%; 2-Serbia, 1.01(0.05)%; ... 4-Russia, 0.93(0.02)%; ... 17-Mexico, 0.567(0.005)%; ... 21-Italy, 0.51(0.02)%; ... 30-USA, 0.424(0.005)%; ... 36-Brazil, 0.398(0.006)%; ... 61-Sweden, 0.21(0.01)%; ... 63-Canada, 0.196(0.006)%; ... 75-Japan, 0.135(0.009)%; ... 86-Australia, 0.070(0.005)%; ... 93-Greenland, -0.1(0.1)%. See table in **Appendix C**.

The 93 countries having sufficient data comprise a population of 2.363 billion in 2019. The mean excess all-cause mortality during the Covid period (X202122), expressed as a percentage of the national population in 2019, taking the 93 countries with sufficient data as a single jurisdiction, is: $X202122/2019pop = (0.3844 \pm 0.0021)\%$.

Taking this mean fraction to be representative of the world, and adjusting to the world population to 2021 (mid-Covid-period), this implies a total excess all-cause mortality during the Covid period equal to

- (29.8 ± 0.2) million deaths, or
- $(0.377 \pm 0.002)\%$ of 2021 World population,

excluding the excess all-cause mortality from 1 January 2023 through 5 May 2023 of the declared pandemic.

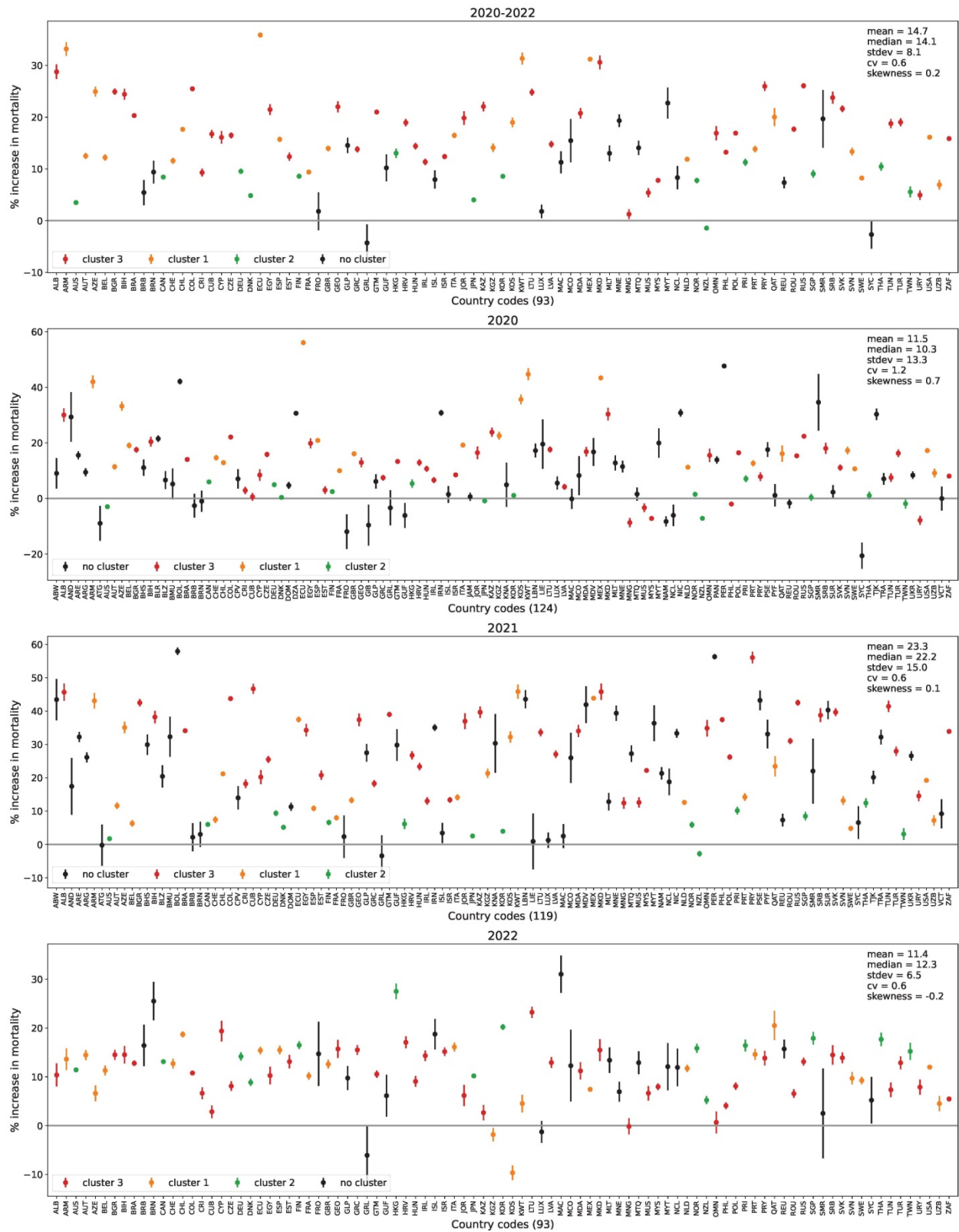
Note that this number (29.8M) is greater than the total number of COVID-19 deaths in the world, reported to the WHO up to 11 February 2024 (7.03M). It is more than 4.2 times greater. However, the 93 countries in question may not be representative of the other countries, in terms of Covid-period excess all-cause mortality, and the reporting

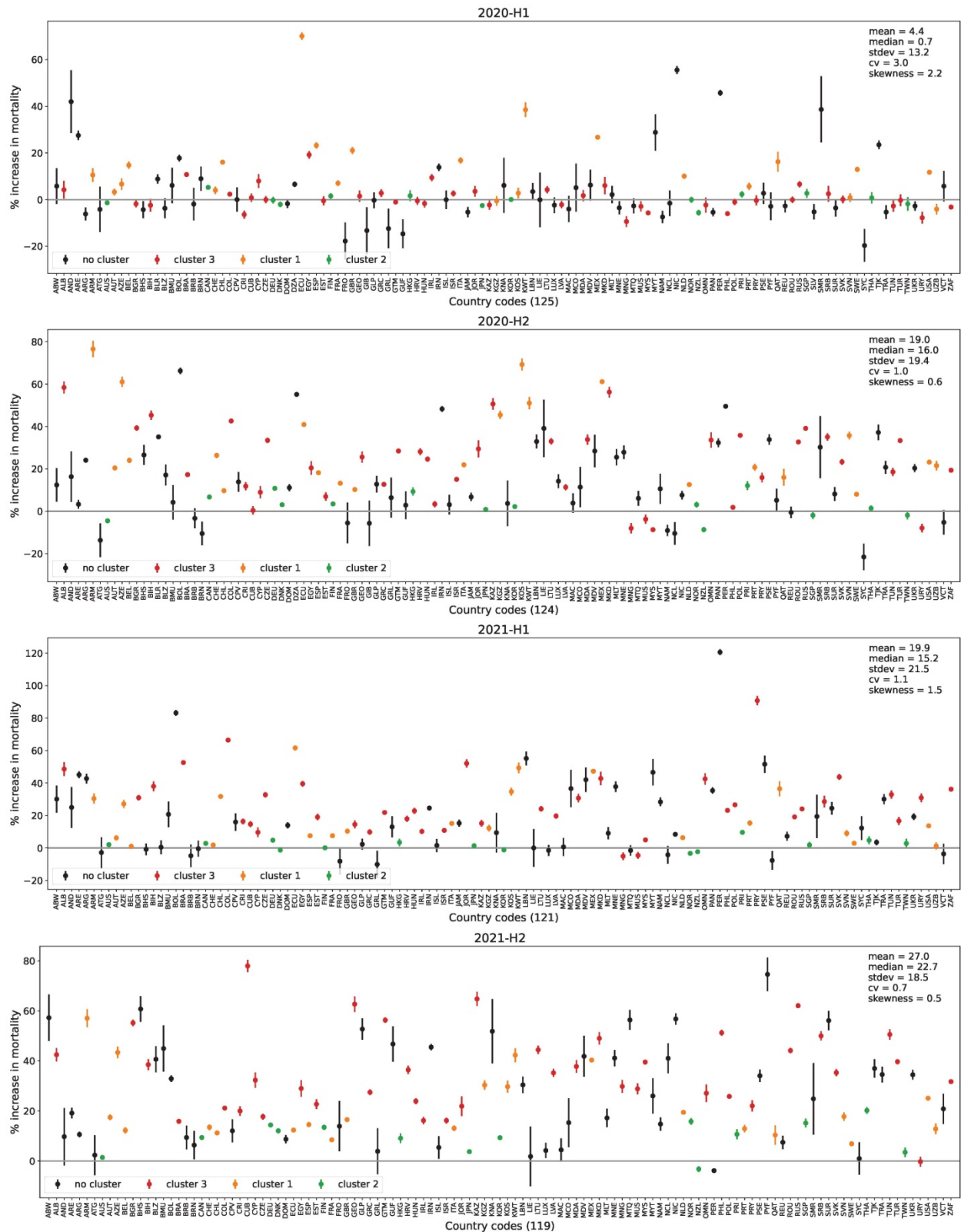
and assignation of “COVID-19 deaths” may be highly incomplete and variably reliable or consistent from country to country.

Similarly, the total excess all-cause mortality in the period 2020-2022 for the 93 countries having sufficient data is 9.086 million, for a total historic baseline value on the same period of 56.737 million (**Appendix C**), which gives an excess-to-baseline ratio, for all 93 countries together, of 16.01 %, whereas the by-country median value is 14.1 % (see below).

Figure 16 shows excess all-cause mortality for each of the eleven periods 2020-2022, 2020, 2021, 2022, and the half calendar years 2020-H1 through 2023-H1, expressed as a percentage of the predicted (extrapolated historical trend, see Methods) mortality for the same period, with 1σ error bars, by country (as labelled, with country codes in alphabetical order).

Each panel in Figure 16 shows a legend with the corresponding values, for the given time period, of the mean, median, standard deviation, coefficient of variation (standard deviation / mean), and skewness (Fisher-Pearson coefficient of skewness).





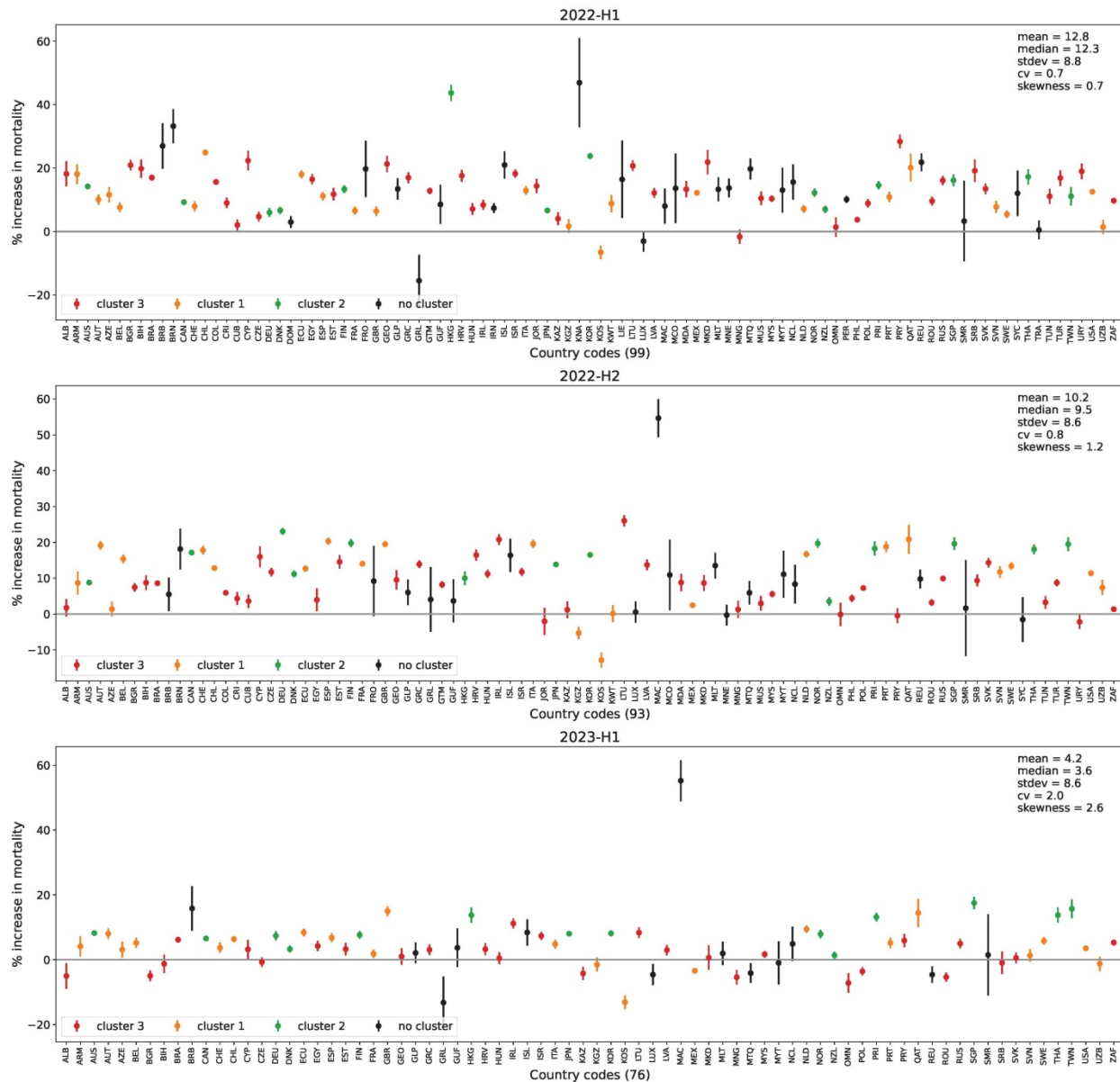


Figure 16. Excess all-cause mortality for the periods (as labelled for each panel) 2020-2022, 2020, 2021, 2022, and each half calendar year 2020-H1 through 2023-H1, expressed as a percentage of the predicted mortality for the same period (“P-score”), with 1σ error bars, by country (as labelled, with country codes in alphabetical order). The colours correspond to the three clusters from the cluster analysis. Each panel shows the values of the mean, median, standard deviation, coefficient of variation (standard deviation / mean), and skewness (Fisher-Pearson coefficient of skewness).

The figure in **Appendix D** shows the same results for excess all-cause mortality as illustrated in Figure 16 but calculated as fractions of 2019 population, rather than as percentages of the predicted mortalities for the same periods.

Table 1 lists the statistical parameters of the country-wise distributions of excess all-cause mortality values, for each time period, and for both as percentage of the predicted mortality for the same period (from Figure 16) and as fraction of 2019 population (from **Appendix D**). The listed statistical parameters are: number of countries (N), mean, median, standard deviation, coefficient of variation (cv = standard deviation / mean), and skewness (Fisher-Pearson coefficient of skewness).

Table 1: Statistical parameters of the country-wise distributions of excess all-cause mortality values, for various time periods

*As percentage of the predicted mortality for the same period (from Figure 16) **

period	N	mean (%)	median (%)	stdev (%)	cv	skewness
2020-2022	93	14.7	14.1	8.1	0.6	+0.2
2020	124	11.5	10.3	13.3	1.2	+0.7
2021	119	23.3	22.2	15.0	0.6	+0.1
2022	93	11.4	12.3	6.5	0.6	-0.2
2020-H1	125	4.4	0.7	13.2	3.0	+2.2
2020-H2	124	19.0	16.0	19.4	1.0	+0.6
2021-H1	121	19.9	15.2	21.5	1.1	+1.5
2021-H2	119	27.0	22.7	18.5	0.7	+0.5
2022-H1	99	12.8	12.3	8.8	0.7	+0.7
2022-H2	93	10.2	9.5	8.6	0.8	+1.2
2023-H1	76	4.2	3.6	8.6	2.0	+2.6

*As fraction of 2019 population (from Appendix D) **

period	N	mean (10^{-3})	median (10^{-3})	stdev (10^{-3})	cv	skewness
2020-2022	93	3.5	3.1	2.5	0.7	+0.8
2020	124	0.79	0.65	0.94	1.2	+0.4
2021	119	1.7	1.3	1.4	0.8	+0.9
2022	93	0.92	0.92	0.60	0.6	+0.1

2020-H1	125	0.11	0.026	0.37	3.4	+1.2
2020-H2	124	0.67	0.49	0.77	1.1	+0.9
2021-H1	121	0.70	0.47	0.75	1.1	+0.9
2021-H2	119	1.0	0.74	0.91	0.9	+1.3
2022-H1	99	0.52	0.47	0.40	0.8	+0.5
2022-H2	93	0.40	0.37	0.33	0.8	+0.5
2023-H1	76	0.11	0.12	0.22	2.1	-0.2

* The orange and blue colours are to highlight largest values, for years and half years, respectively.

From Table 1, note that:

- The excess all-cause mortality, relative to the extrapolated historical trend baseline, during the declared pandemic (during the Covid period) has a country-to-country median magnitude, for the countries in the present study, equal to 4.7% on average per year of expected historical baseline, or 1.0 per 1000 of 2019 population on average per year, during 2020-2022.
- If every country experienced the country-to-country median excess mortality observed in the present study (93 countries having data up to 2022) during the nominal 2020-2022 Covid period, then using the 2021 estimated global population (7.9 billion), this would correspond to $0.31\% \times 7.9 \text{ billion} = 24 \text{ million}$ deaths, which is smaller than the above estimate of (29.8 ± 0.2) million deaths, based on overall average mortality (total for countries in the study). The difference between these two estimates is due to many small countries having relatively smaller excess mortalities: the country-to-country median is not representative of large countries in which most excess deaths occur.
- In every time period during the declared pandemic (2020-2022, 2020, 2021, 2022, and every half year up to and including 2023-H1) there is a large country-to-country variability in excess all-cause mortality, quantified as coefficients of variation ($cv = \text{standard deviation} / \text{mean}$) in the range 0.6 to 3.4. These are exceptionally large country-to-country coefficients of variability of excess all-cause mortality.

- By far, the largest coefficient of variability ($cv = 3.0$ or 3.4 , by percent or by population, respectively) occurred in the first half year of 2020, following when the pandemic was declared on 11 March 2020. The disparity in excess mortality from country to country is exceptionally large in this period, possibly unprecedented for human populations in any large-scale regional mortality-causing event (pandemic, war, economic crash, ecological collapse). Even the lesser later values of cv are likewise exceptional. Likewise, skewness of the distribution is typically largest for this half year (2020-H1, Table 1), arising from large-value outliers (Figure 16).
- The year of largest excess all-cause mortality, in the present study, is unquestionably 2021, rather than 2020 or 2022.
- The half year of largest excess all-cause mortality is the second half of 2021 (2021-H2, Table 1), with a country-to-country median magnitude, for the countries in the present study, equal to 45.4% on a per year basis of expected historical baseline, or 1.5 per 1000 of 2019 population on a per year basis, during 2021-H2.

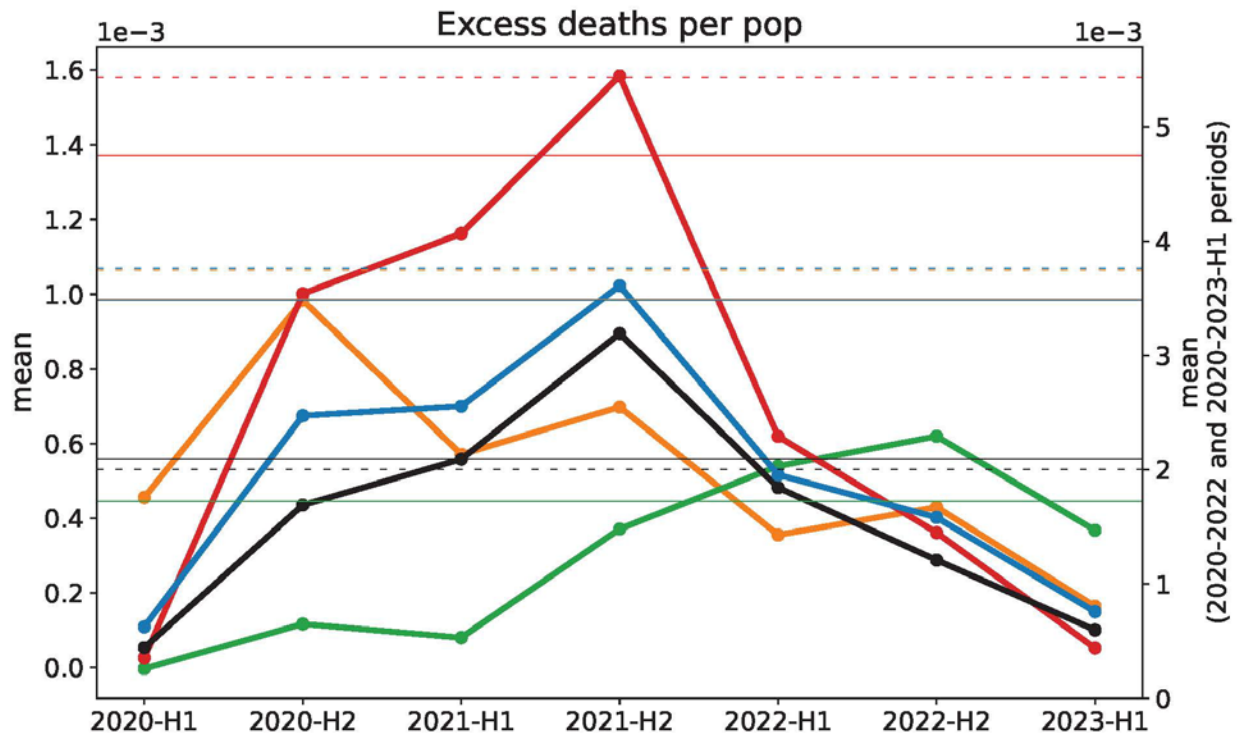
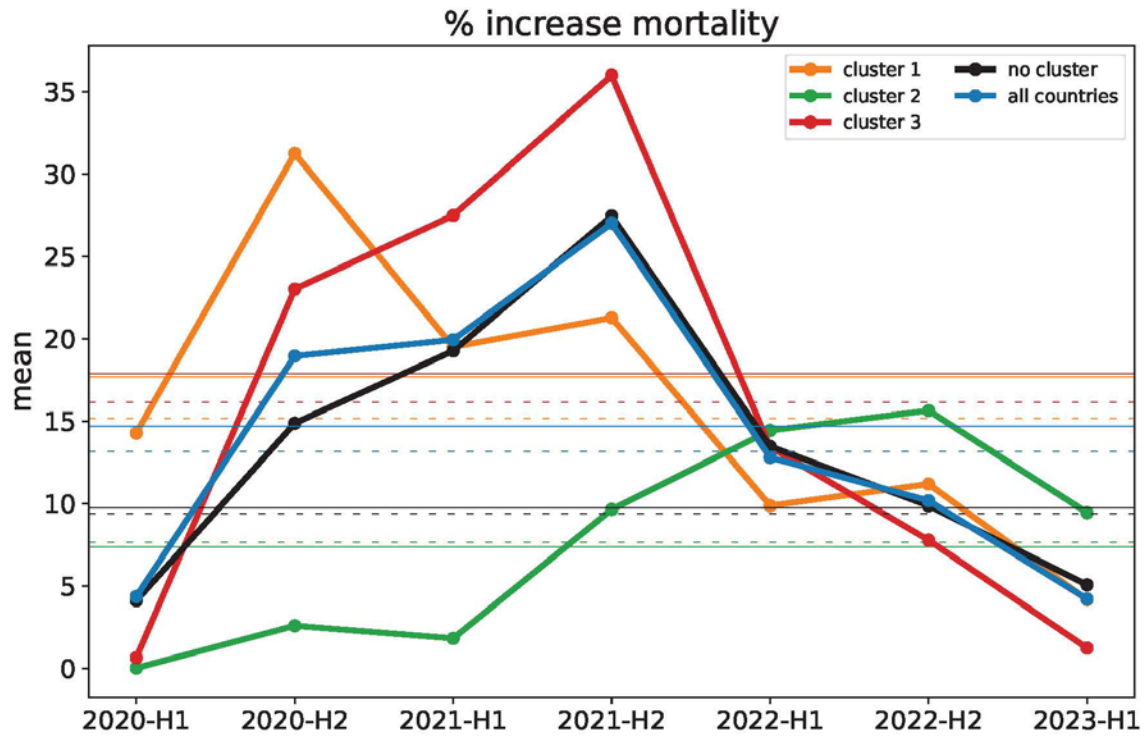
An equivalent analysis is made for each separate cluster-analysis group of countries (Section 4.7) and these results are presented in the following Section 4.10.

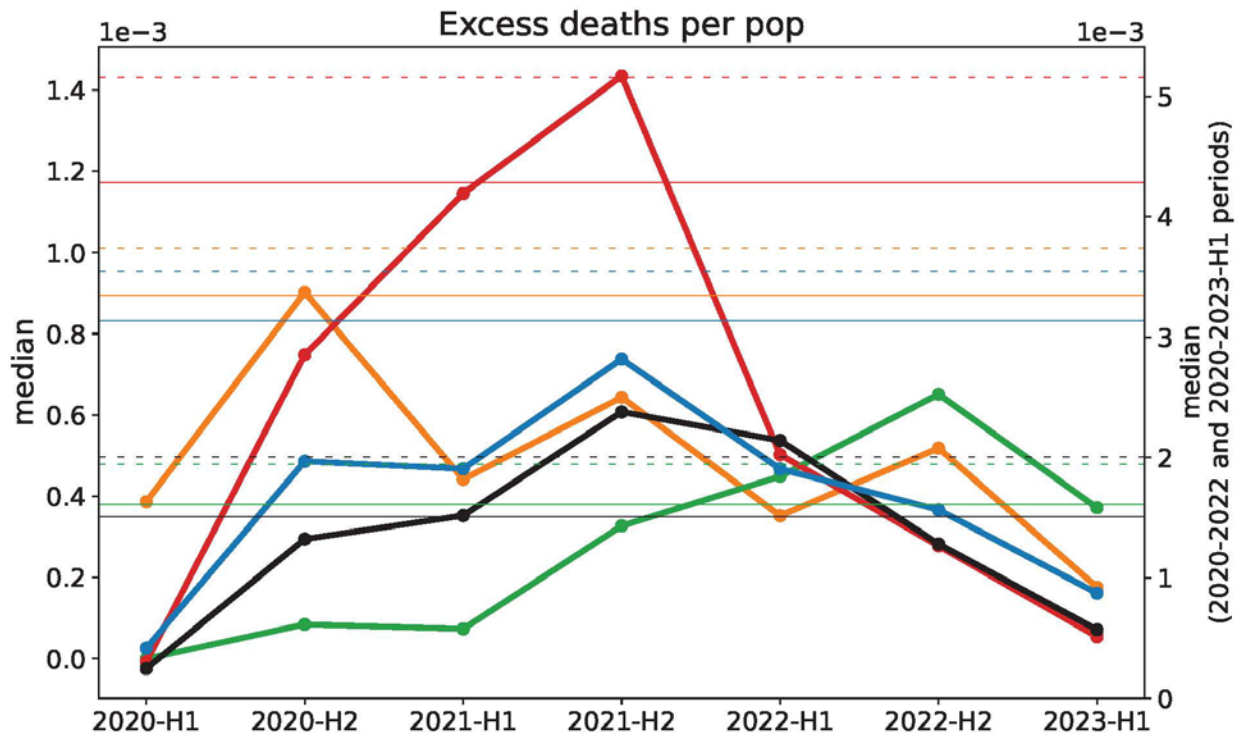
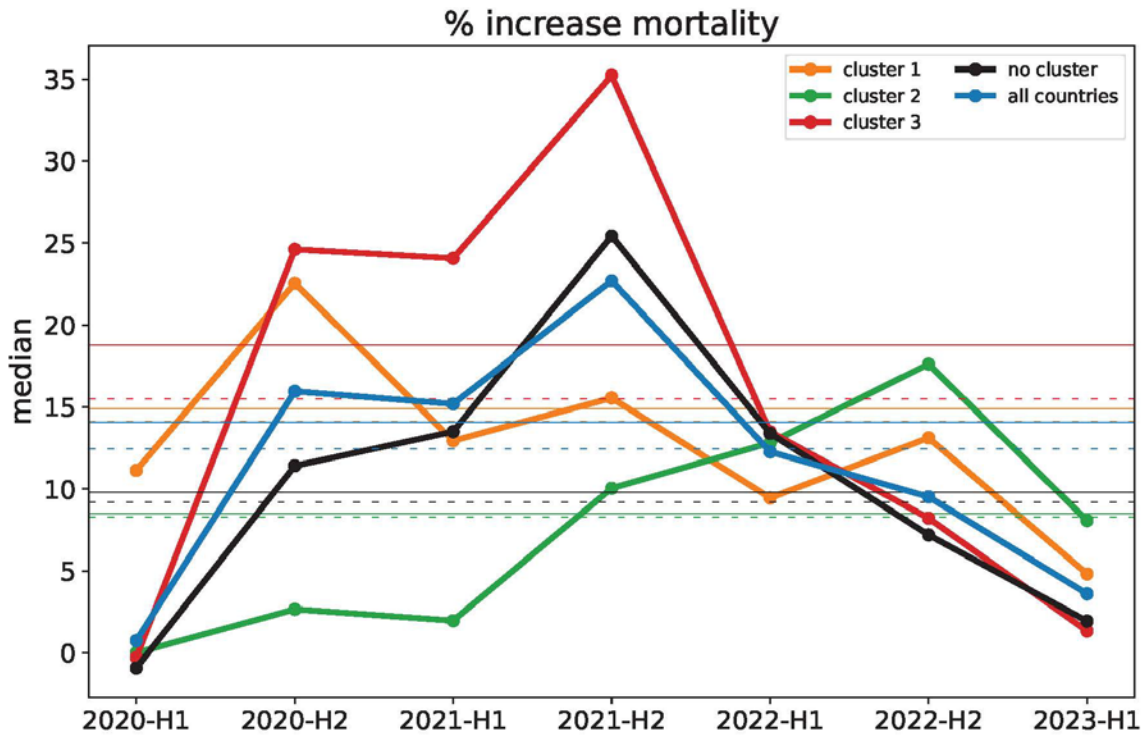
4.10 Statistics of excess all-cause mortality by time period for cluster-analysis groups of countries

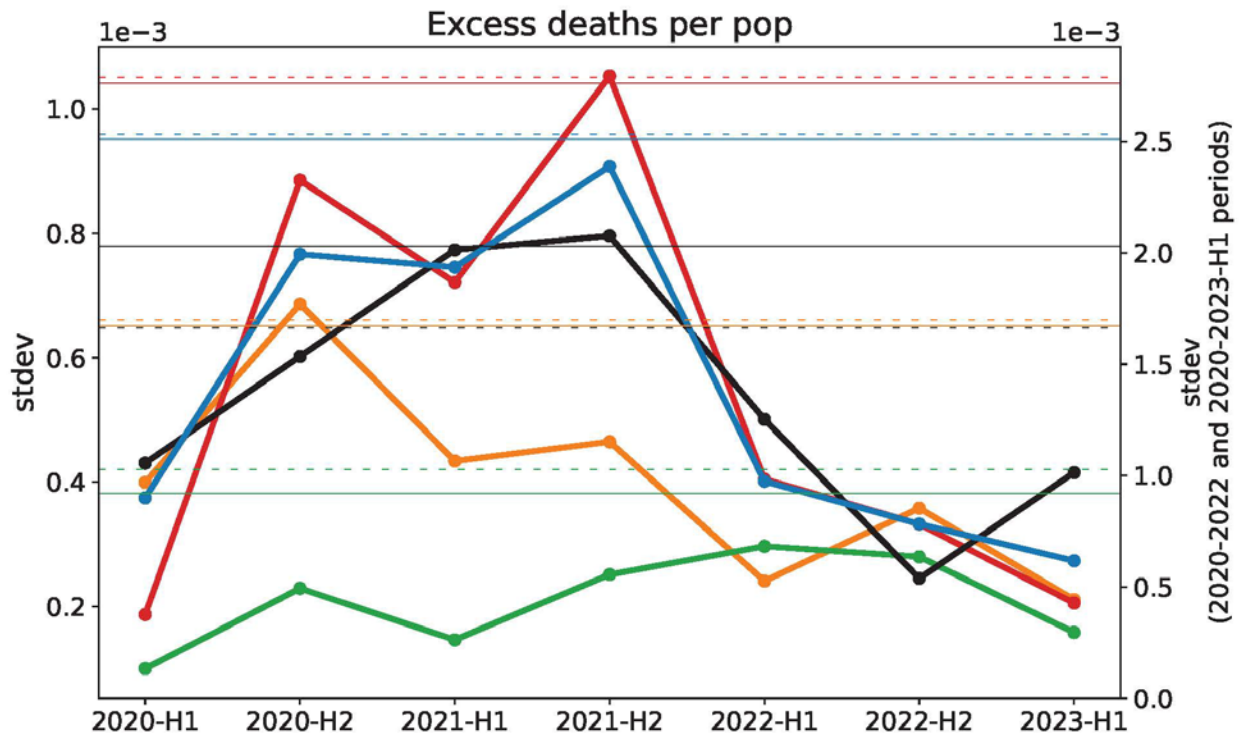
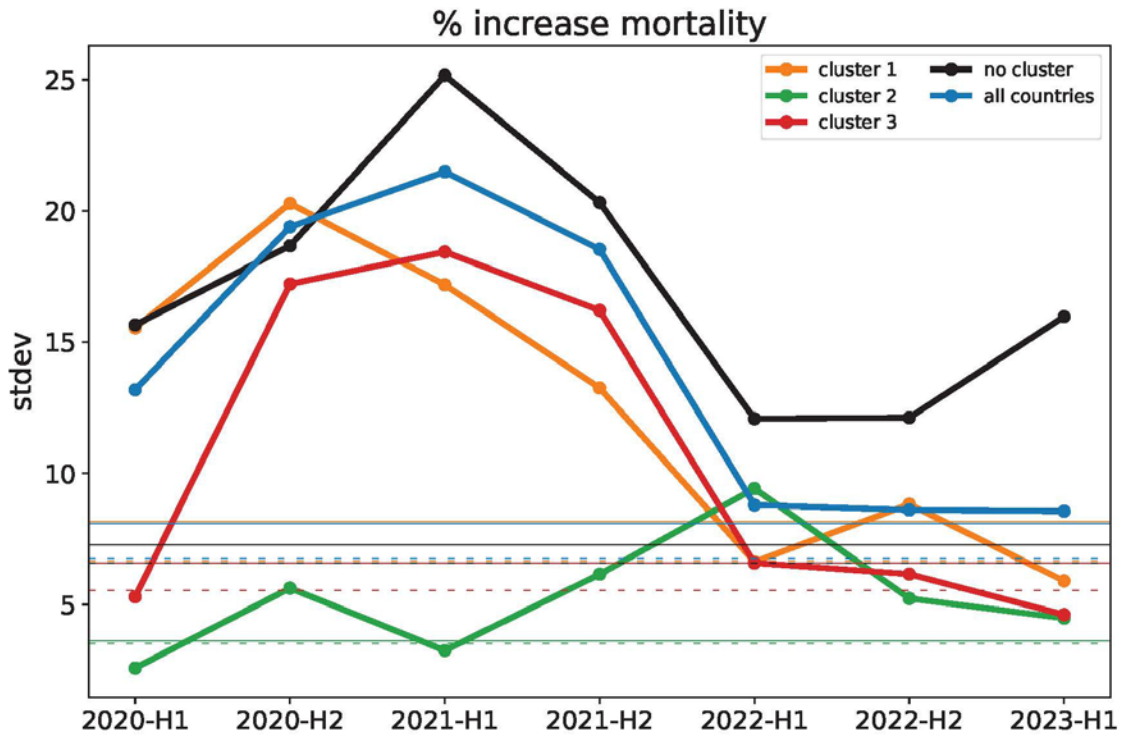
The results presented in Table 1 are shown graphically versus integration-time period, and for each of the cluster-analysis groups of countries identified in Section 4.7, as follows.

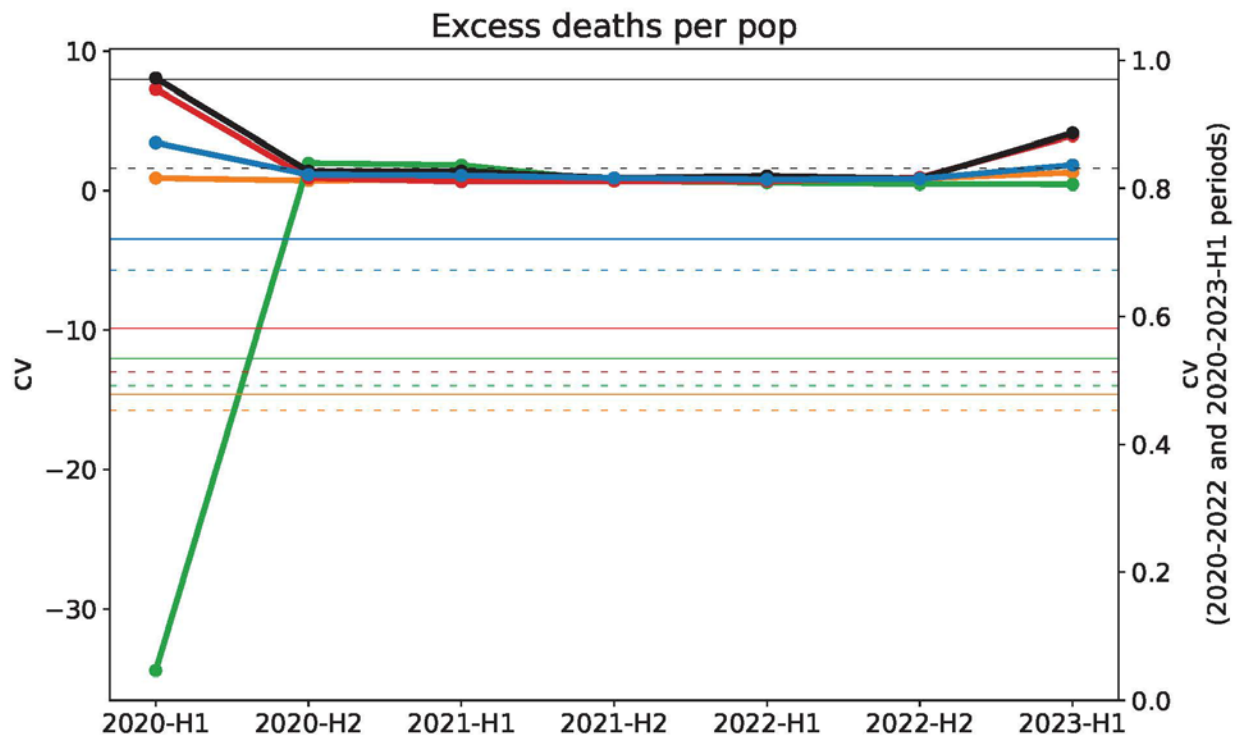
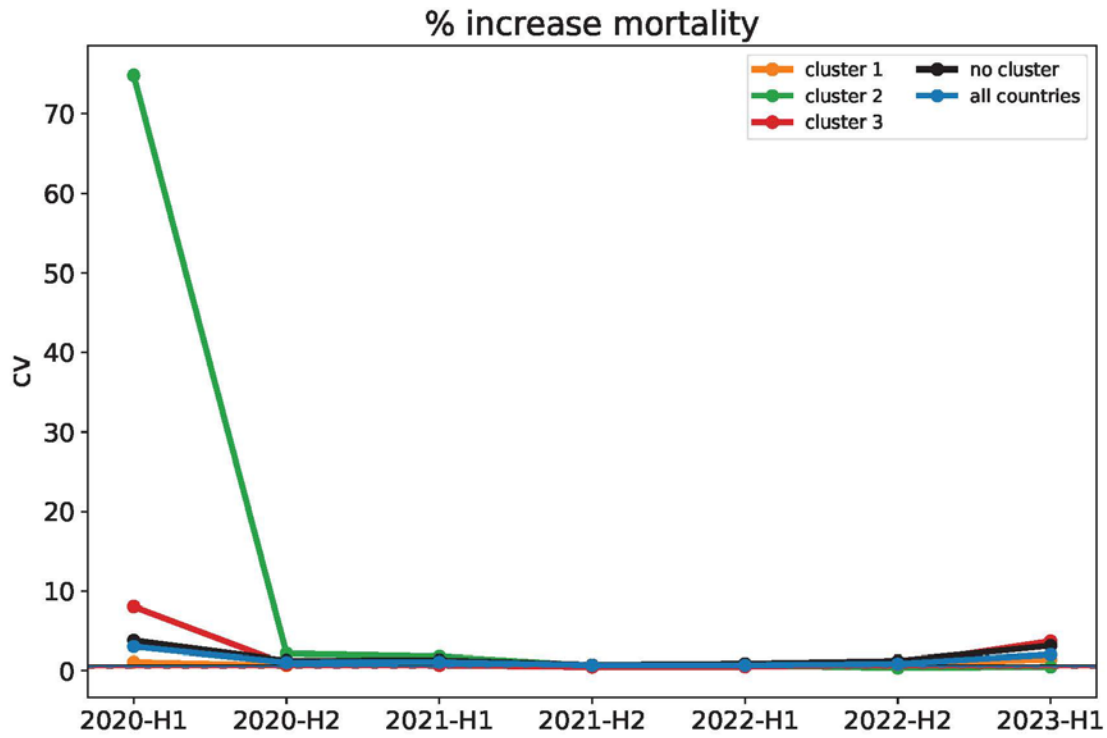
Figure 17 shows the mean, median, standard deviation, and coefficient of variation ($cv = \text{standard deviation} / \text{mean}$) values of the excess all-cause mortality (normalized either by population or by historic baseline all-cause mortality) for all countries (blue) in the present study and for countries in each of the identified clusters of countries

(Section 4.7: cluster 1, orange; cluster 2, green; cluster 3, red; no cluster, black, 2019 population ≤ 1 million, or data ends prior to end of 2022), and for each of several different time periods of integration (2020-2022, 2020-2023-H1, and each half year 2020-H1 through 2023-H1).









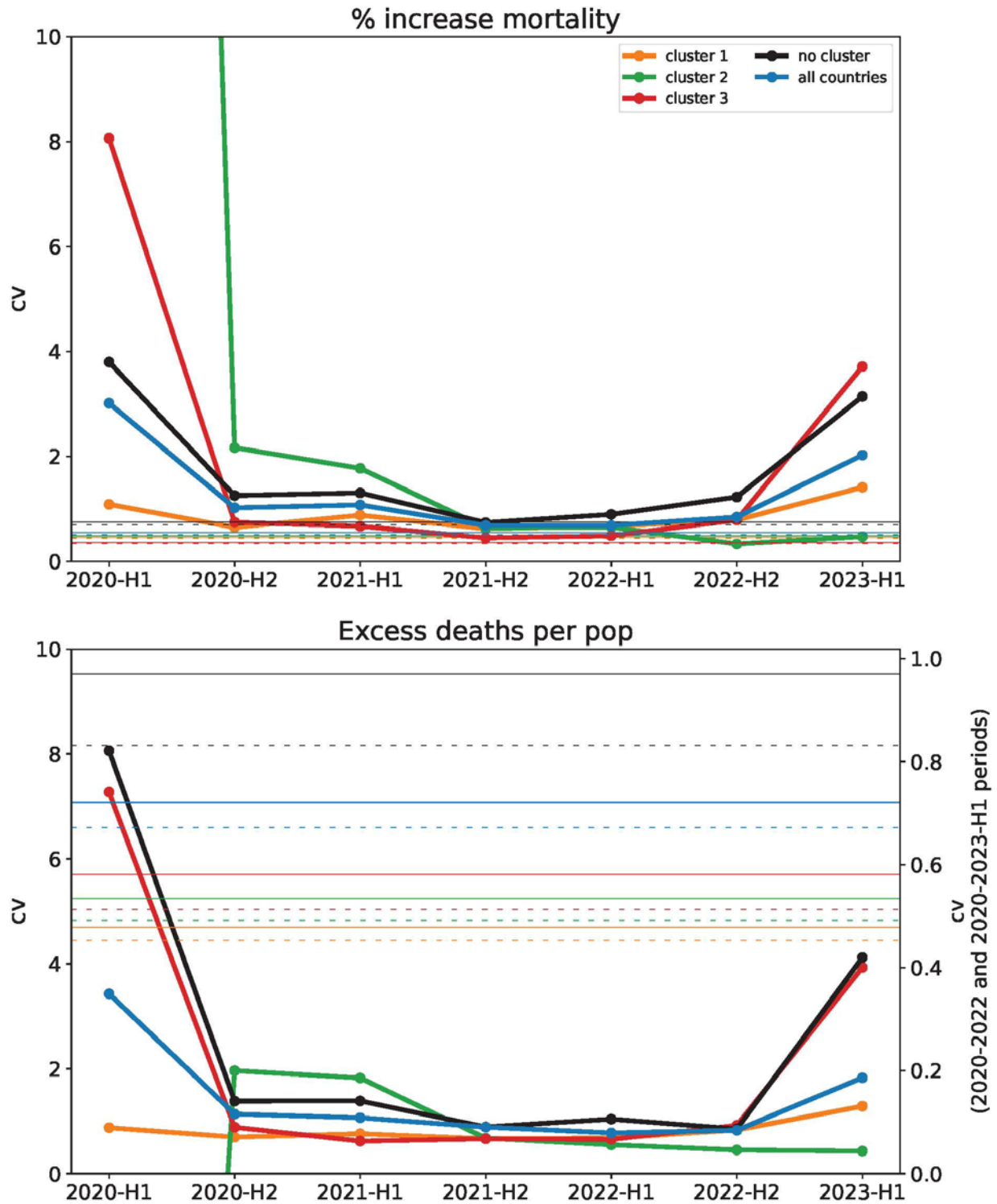


Figure 17. Statistical parameters of the distributions of values of excess all-cause mortality (mean, median, standard deviation, and coefficient of variation, as per labelled y-axes), for normalization by historic baseline all-cause mortality (top panel for each parameter) and by 2019 population (bottom panel for each parameter), versus half year 2020-H1 through 2023-H1. Each panel has five datasets, for: cluster 1 countries (orange),

cluster 2 countries (green), cluster 3 countries (red), no cluster countries (black), and all countries (blue). Solid horizontal lines (same colours) show the values for time period 2020-2022, dashed horizontal lines for 2020-2023-H1.

4.11 Spatial distribution of Covid-period excess all-cause mortality in the world

The values of excess all-cause mortality during the Covid period (actually, 2020-2022; X202122), expressed as a percentage of the national 2019 population, for the 93 countries with sufficient data, are shown on a world map in Figure 18.

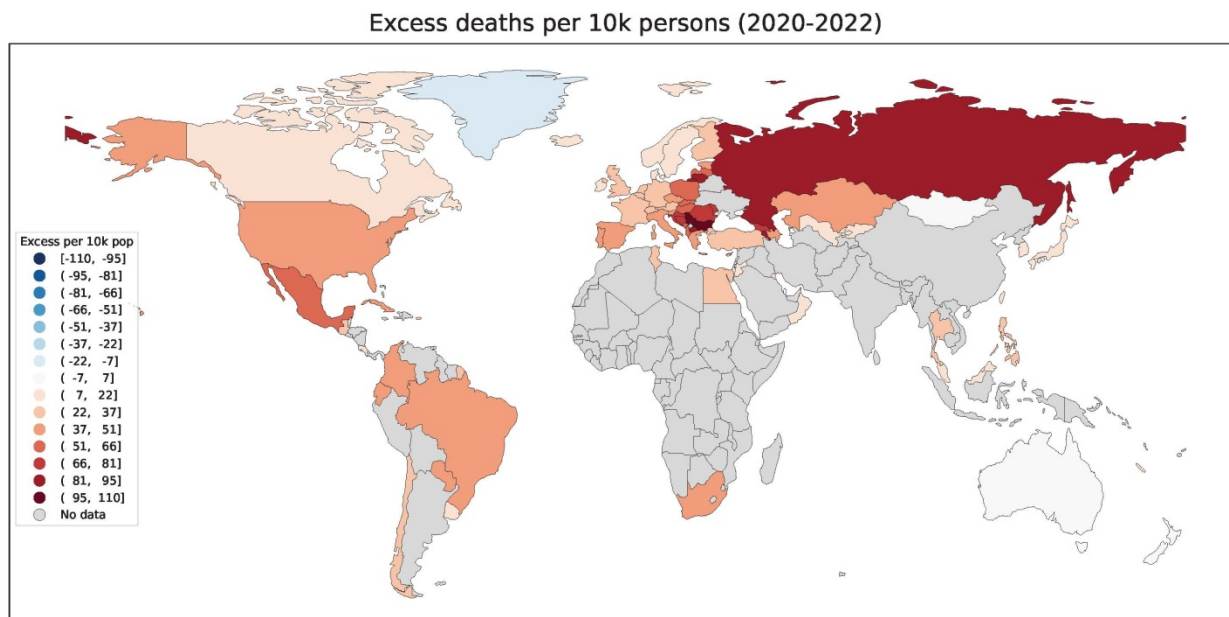


Figure 18. World map of excess all-cause mortality during the Covid period (X202122), by country, expressed as a percentage of the national population in 2019, for the 93 countries with sufficient data.

The excess all-cause mortality during the Covid period (X202122) can also be expressed as a percentage of the predicted mortality for the same period (2020-2022) deduced from the pre-Covid historic trend, for the 93 countries with sufficient data. This accounts for the varying country-specific pre-Covid mortality rates. These values are shown on a world map in Figure 19.

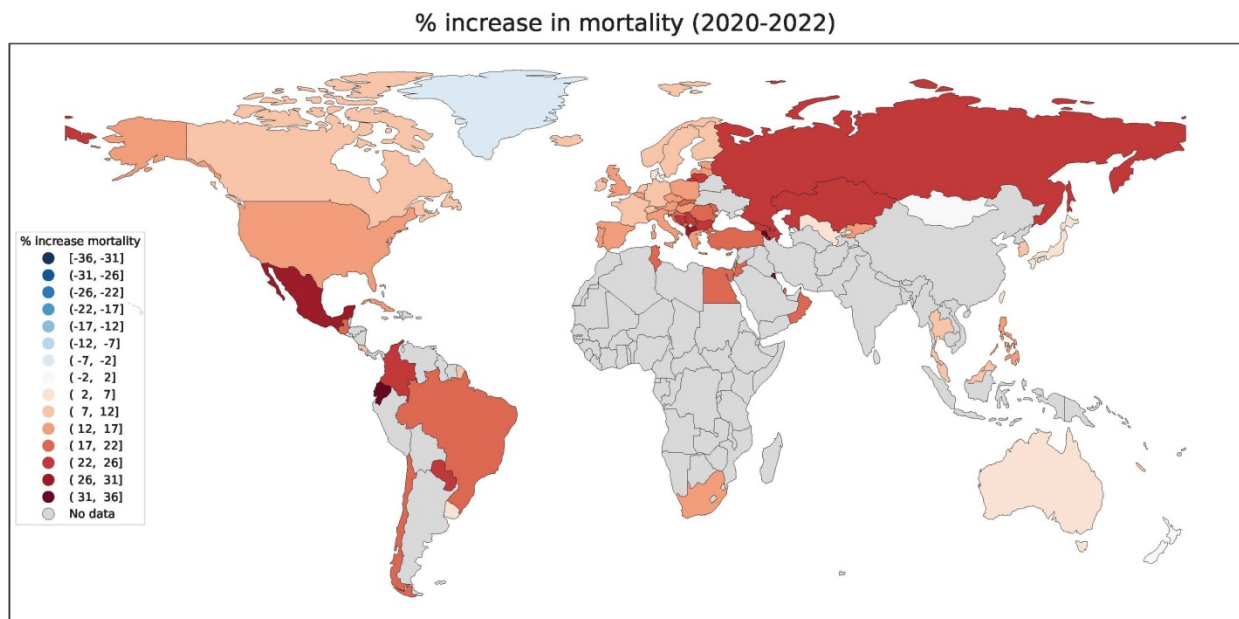


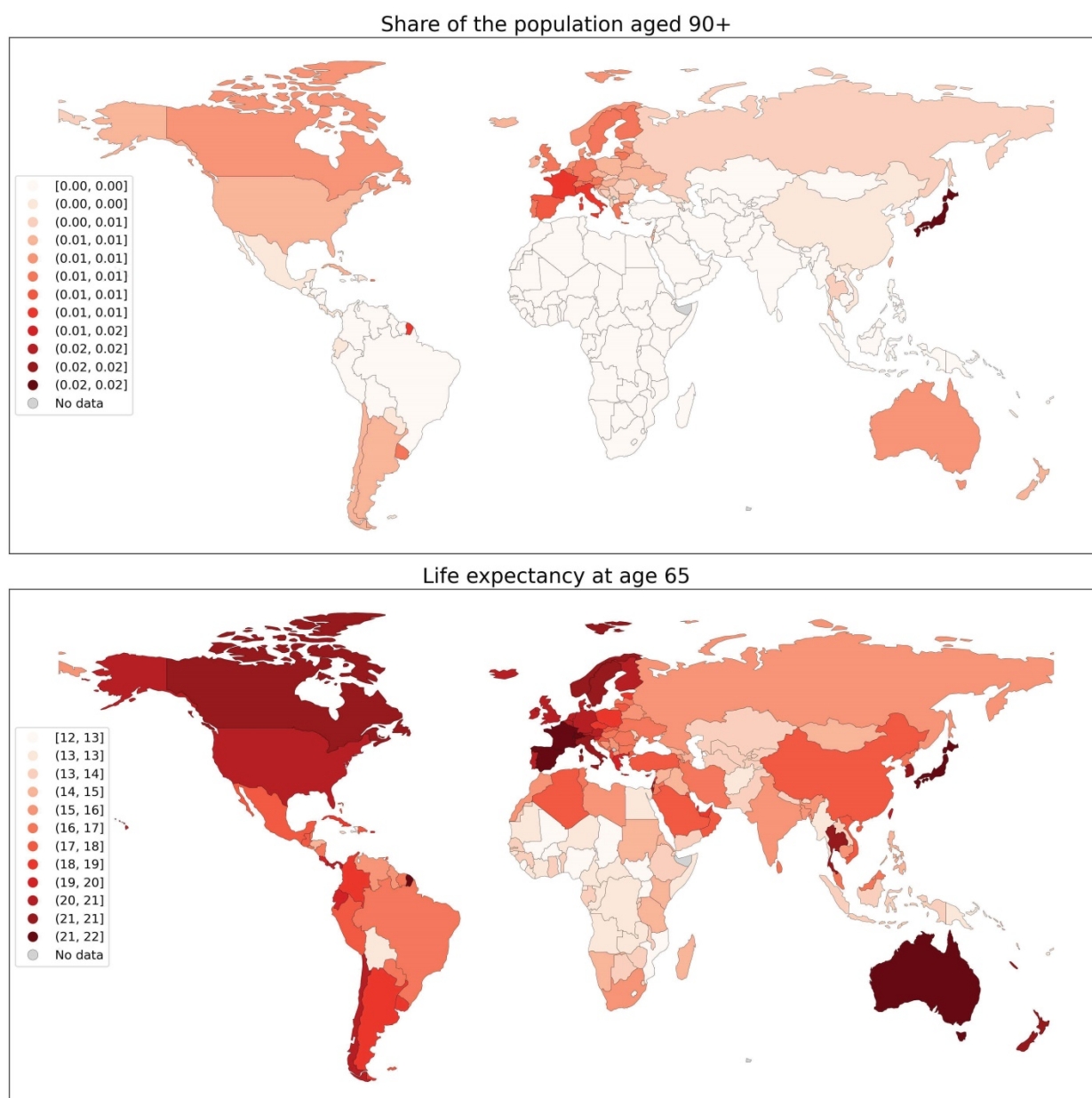
Figure 19. World map of excess all-cause mortality during the Covid period (X202122), expressed as a percentage of the predicted mortality for the same period (2020-2022) deduced from the pre-Covid historic trend (“P-score”), for the 93 countries with sufficient data.

Note the following general features shown in Figure 18 and Figure 19:

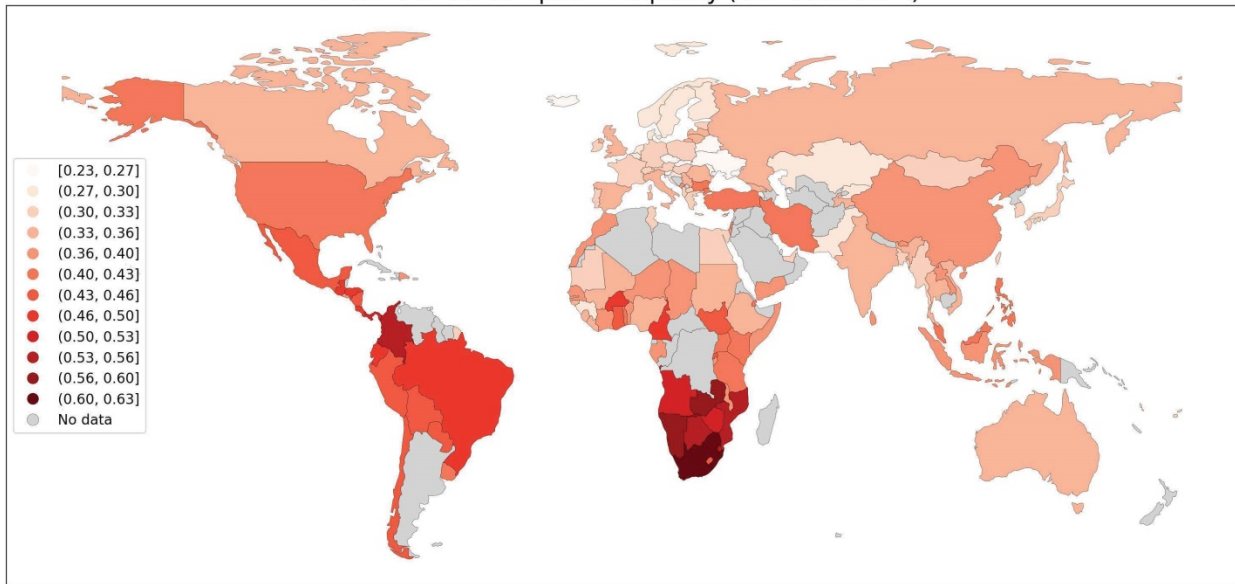
- There is an East-West divide in Europe, with Eastern European nations having significantly larger Covid-period mortality, and among the largest in the world
- There is a large north-south gradient in North America, with significantly increasing Covid-period mortality in going from Canada to USA to Mexico
- Australia, New Zealand and Japan have relatively small (near-zero for New Zealand) Covid-period mortality
- Major and populous continental-scale regions of the world have no data on these maps

The same general features (East-West divide in Europe; north-south gradient in North America; Australia-New Zealand-Japan) are apparent in the world maps of several socio-economic variables. Notably, with life expectancy at age 65, share of population aged 90+, income or consumption inequality (Gini coefficient), share of population living

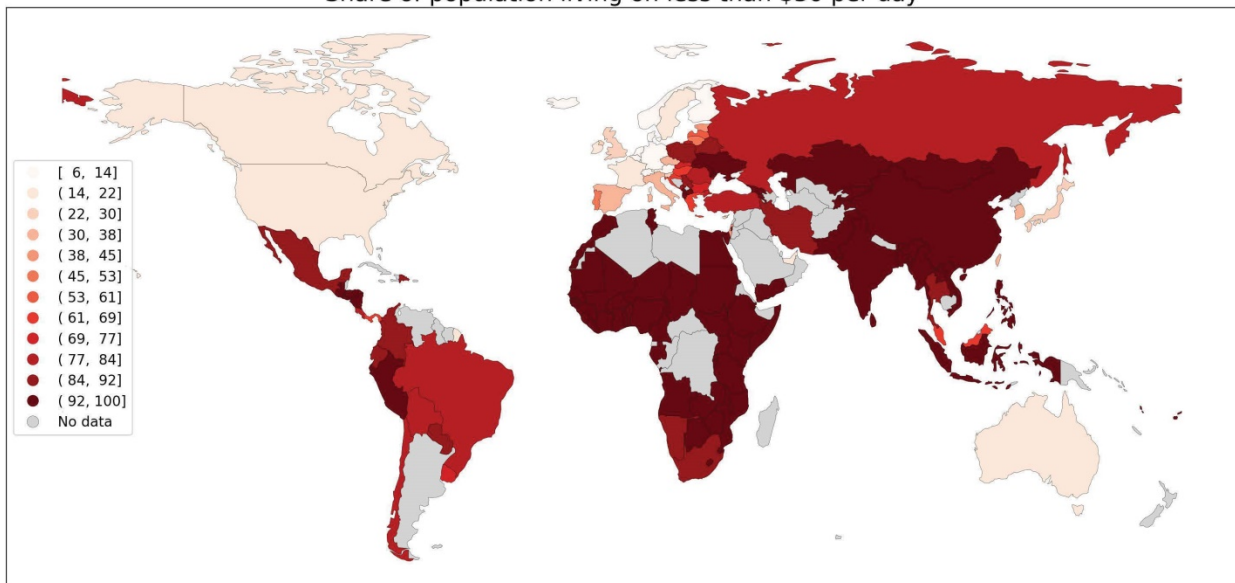
on less than \$30 per day, and mean income or consumption per day within the poorest decile (tenth of the population) (Intl-\$), as illustrated in the five panels of Figure 20. Here, the socio-economic data are from the sources specified in Section 2.



Income or consumption inequality (Gini coefficient)



Share of population living on less than \$30 per day



Mean income or consumption per day within the poorest decile (tenth of the population) (Intl-\$)

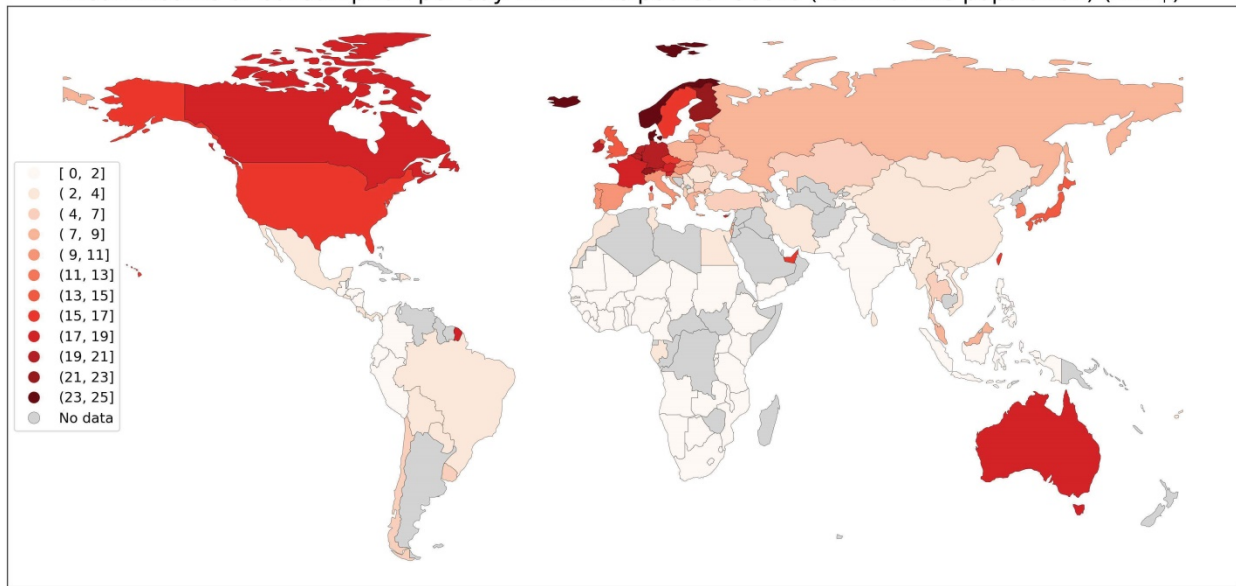


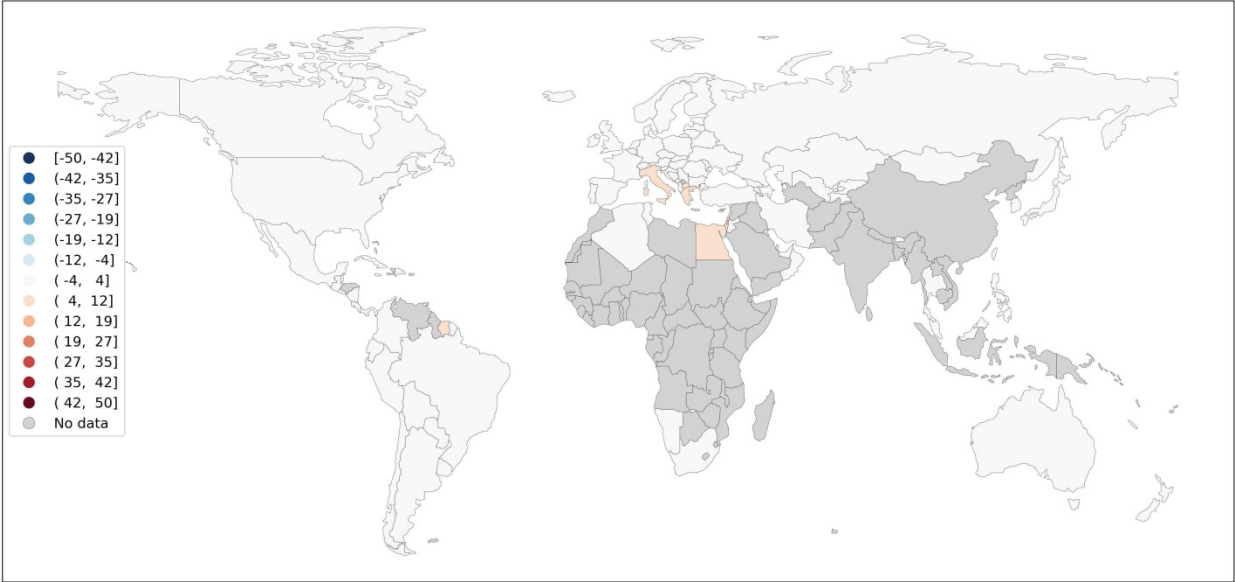
Figure 20. World maps of select socio-economic variables (as labelled): life expectancy at age 65, share of population aged 90+, income or consumption inequality (Gini coefficient), share of population living on less than \$30 per day, and mean income or consumption per day within the poorest decile (tenth of the population) (Intl-\$).

4.12 Spatiotemporal variation of Covid-period excess all-cause mortality in the world

As is clear from Appendix A and Appendix B, excess all-cause mortality by country is far from uniform in time during the Covid period. Therefore, it is far more informative to examine the world map of excess mortality by half year through the Covid period (2019-2023), rather than for the near-entirety of the Covid period (X202122).

The 9 panels of Figure 21 show the time sequence of world maps of excess all-cause mortality by half year ("H1", "H2") through the Covid period (2019-2023: 2019-H1, 2019-H2, 2020-H1, ... 2023-H1), expressed as a percentage of the predicted mortality for the given half year deduced from the pre-Covid historic trend, for the countries with sufficient data for each half year. Here, the colour coding is capped at 50 (%) for all the maps to aid visualization.

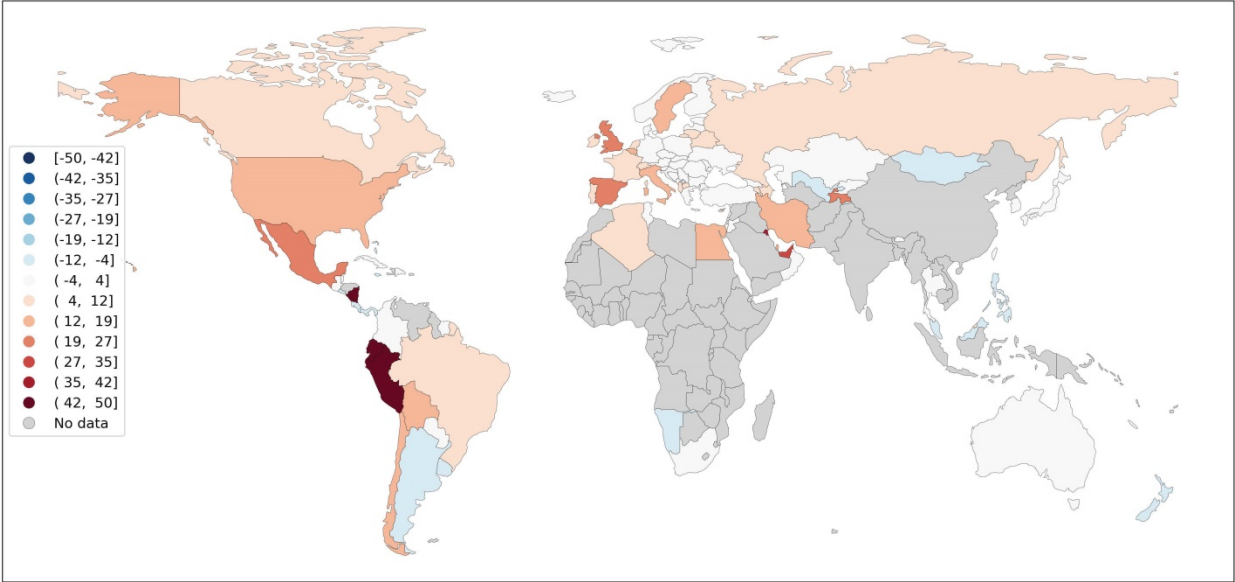
% increase in mortality (2019-01-01 to 2019-06-30)



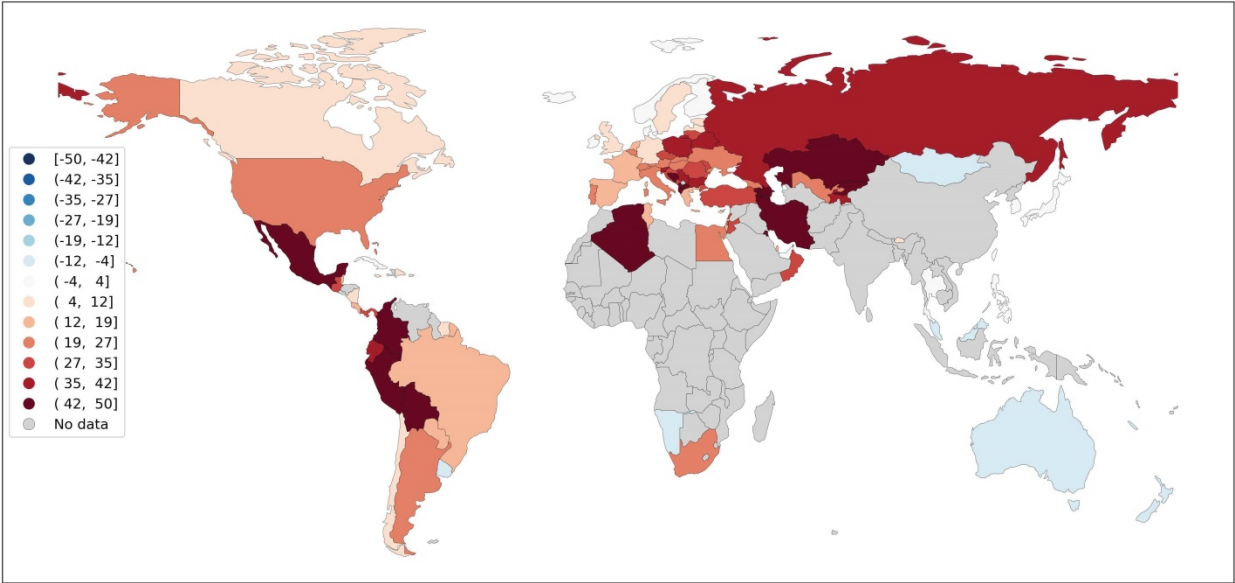
% increase in mortality (2019-07-01 to 2019-12-31)



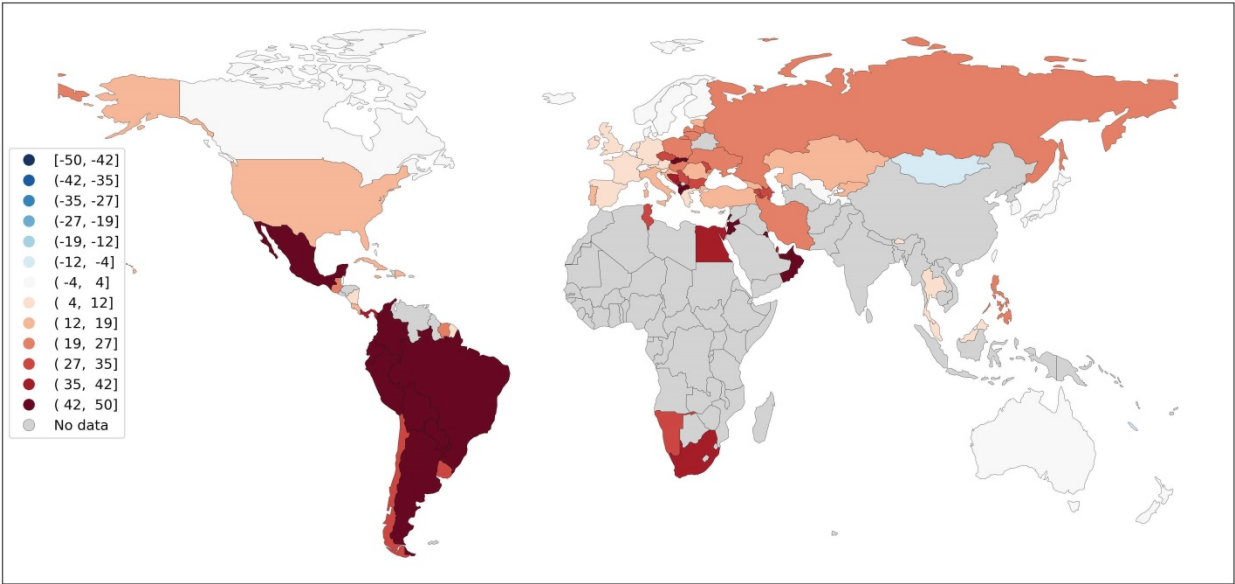
% increase in mortality (2020-01-01 to 2020-06-30)



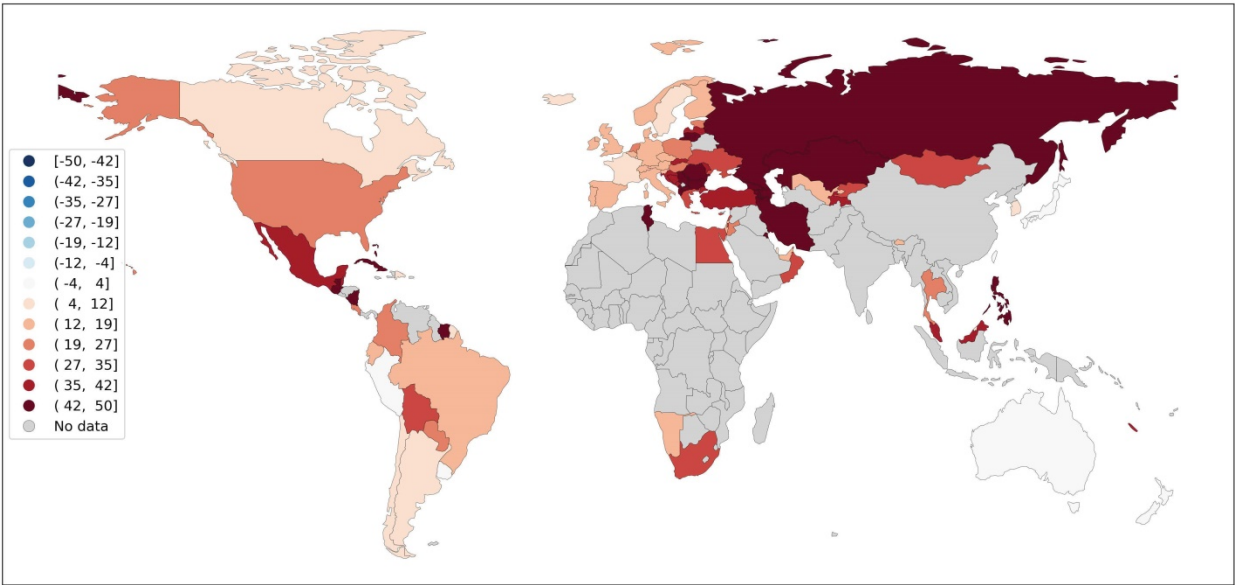
% increase in mortality (2020-07-01 to 2020-12-31)



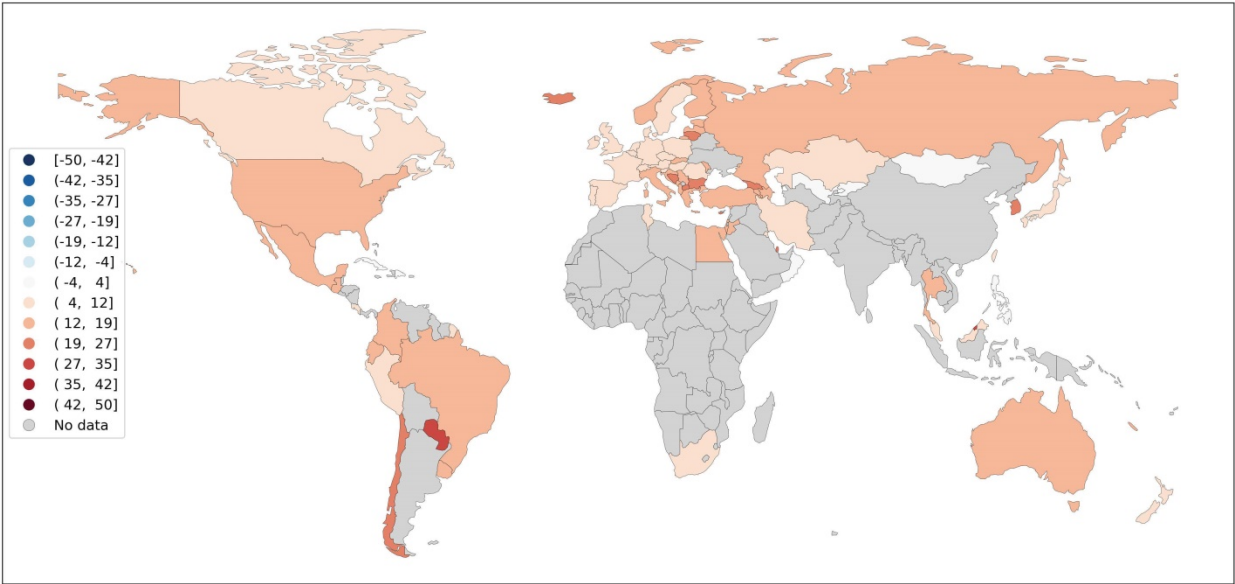
% increase in mortality (2021-01-01 to 2021-06-30)



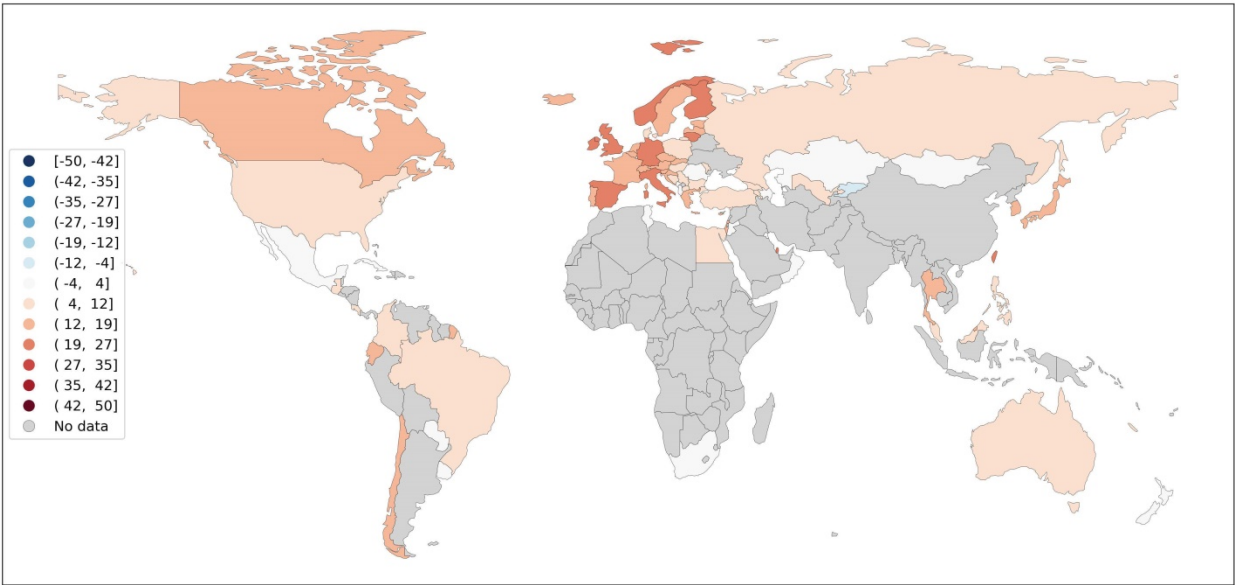
% increase in mortality (2021-07-01 to 2021-12-31)



% increase in mortality (2022-01-01 to 2022-06-30)



% increase in mortality (2022-07-01 to 2022-12-31)



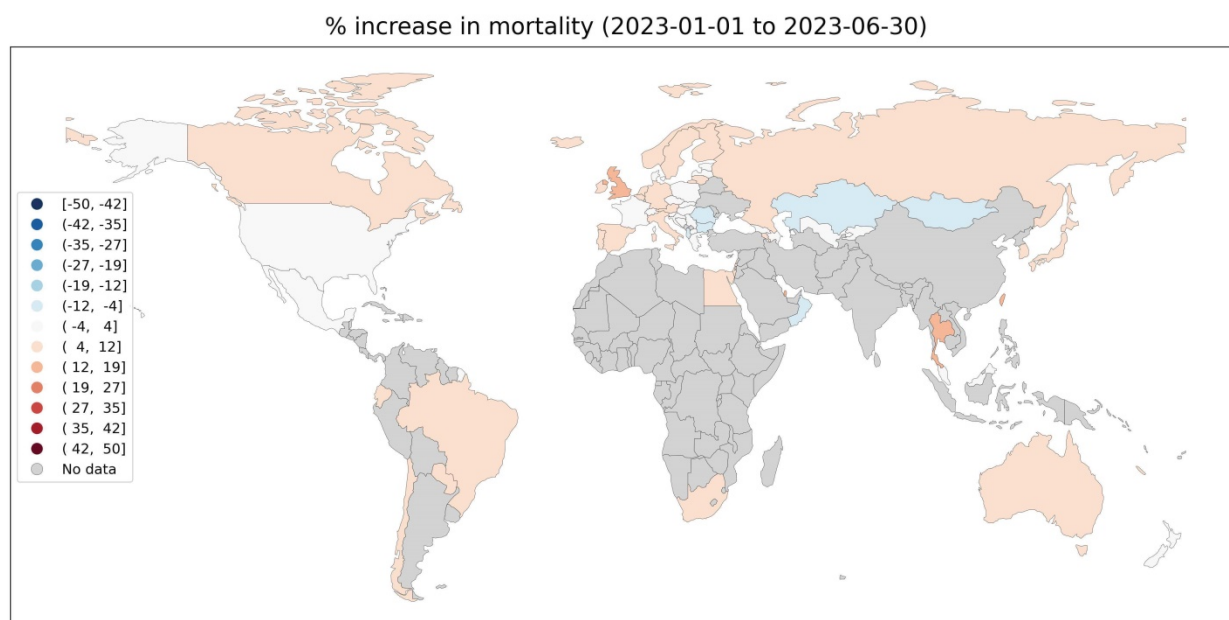


Figure 21. Time sequence of world maps of excess all-cause mortality by half year through the Covid period (top to bottom: 2019-H1, 2019-H2, 2020-H1, ... 2023-H1), expressed as a percentage of the predicted mortality for the given half year deduced from the pre-Covid historic trend (“P-score”), for the countries with sufficient data for each half year. The colour coding is capped at 50 (%) for all the maps to aid visualization.

The equivalent is shown, but on a per-population basis rather than on the predicted mortality basis, in the 9-panel figure of **Appendix E**, where the colour coding is capped at 25 excess deaths per 10k population for all the maps to aid visualization.

4.13 Comparison to COVID-19-assigned deaths and to COVID-19-assigned cases

As noted above, the projected Covid-period excess all-cause mortality for the world (29.8 ± 0.2 million) is significantly larger than the world COVID-19-assigned-death mortality up to 11 February 2024 reported by WHO (7.03 million).

This disparity is smaller when we use the country-specific Covid-period COVID-19-assigned-death mortality reported to WHO, for the same 93 countries having mortality data through 2022 in the present study, and which were used to project the said Covid-period excess all-cause mortality for the world.

Figure 22 shows the ratio of Covid-period excess all-cause mortality (excess all-cause mortality 2020-2022, X202122) to Covid-period COVID-19-assigned-death mortality reported to WHO, for the 91 countries having both sufficient all-cause mortality data in the present study and available COVID-19-assigned-death mortality data, excluding three outliers from the figure (Uzbekistan, +2,070 %; Egypt, +1,450 %; Greenland, -330 %).

Including the outliers, the resulting ratio has a country-wise average of 217 %, a median value of 155 %, and a standard deviation of 273 %, as per the figure legend. Here, the Covid-period COVID-19-assigned-death mortality data is from Worldometer (2024).

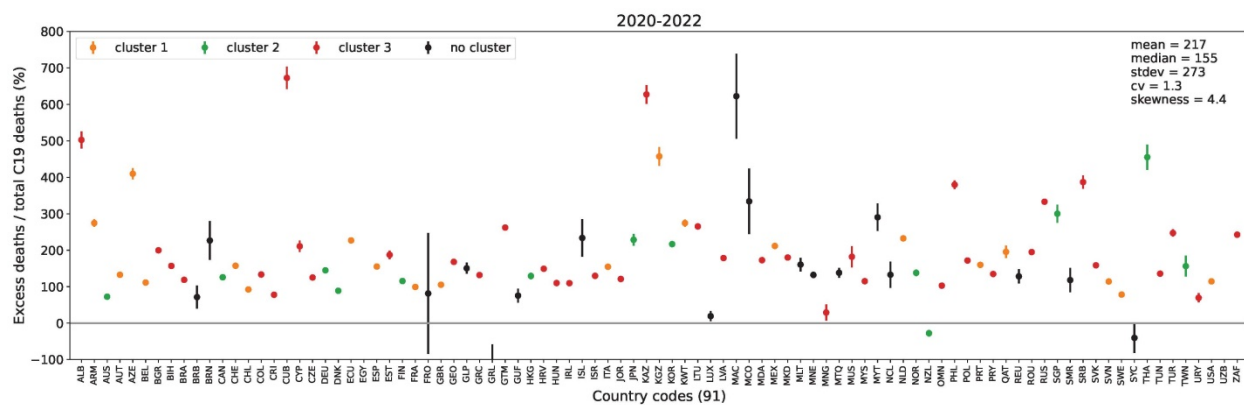


Figure 22. Ratio of Covid-period excess all-cause mortality (2020-2022, X202122) to Covid-period COVID-19-assigned-death mortality reported to WHO, expressed as percentages, with error bars from the 1σ uncertainty in X202122, for the 91 countries having both sufficient all-cause mortality data in the present study and available COVID-19-assigned-death mortality data, excluding three outliers from the figure (Uzbekistan, +2,070 %; Egypt, +1,450 %; Greenland, -330 %). The colours correspond to the three clusters from the cluster analysis.

Likewise, Figure 23 shows the ratio of Covid-period excess all-cause mortality (X202122) to Covid-period COVID-19 cases reported to WHO, for the 91 countries having both sufficient all-cause mortality data in the present study and available COVID-19 cases data, excluding two outliers (Egypt, +69.0 %; Uzbekistan, +13.4 %).

Including the outliers, the resulting ratio (or presumed case fatality rate, CFR) has a country-wise average of 2.8 %, a median value of 1.1 %, and a standard deviation of 7.4 %, as per the figure legend. These would be extraordinarily large all-ages (overall population) actual CFR values. Here, the Covid-period COVID-19 cases data is from Worldometer (2024).

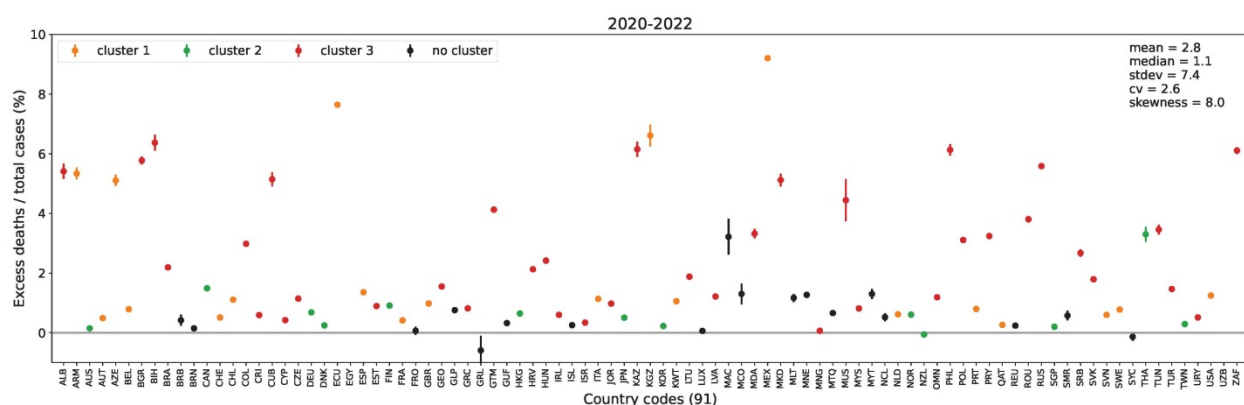


Figure 23. Ratio of Covid-period excess all-cause mortality (2020-2022, X202122) to Covid-period COVID-19 cases reported to WHO, expressed as percentages, with error bars from the 1σ uncertainty in X202122, for the 91 countries having sufficient all-cause mortality data in the present study, as labelled by country code in alphabetical order. The colours correspond to the three clusters from the cluster analysis.

Calculating CFR values as ratios of Covid-period COVID-19-assigned-death mortality reported to WHO to Covid-period COVID-19 cases reported to WHO, expressed as percentages, both from the Worldometer (2024) database, for the 91 countries having sufficient all-cause mortality data in the present study, gives a country-wise average of 1.0 %, a median value of 0.71 %, and no obvious outliers.

4.14 Broad systematics of vaccine rollouts and vaccine injections per population

One of the socio-economic variables we use in the present study is number of vaccine injections per population, which is representative of so-called vaccine coverage. Therefore, we next examine the general features of this variable for the countries in the present study.

Figure 24 shows number of vaccine injections per population in 2022 versus number of vaccine injections per population in 2021, for each country as labelled, using the WHO data on vaccination. Here, the Pearson correlation coefficient (r) is +0.42.

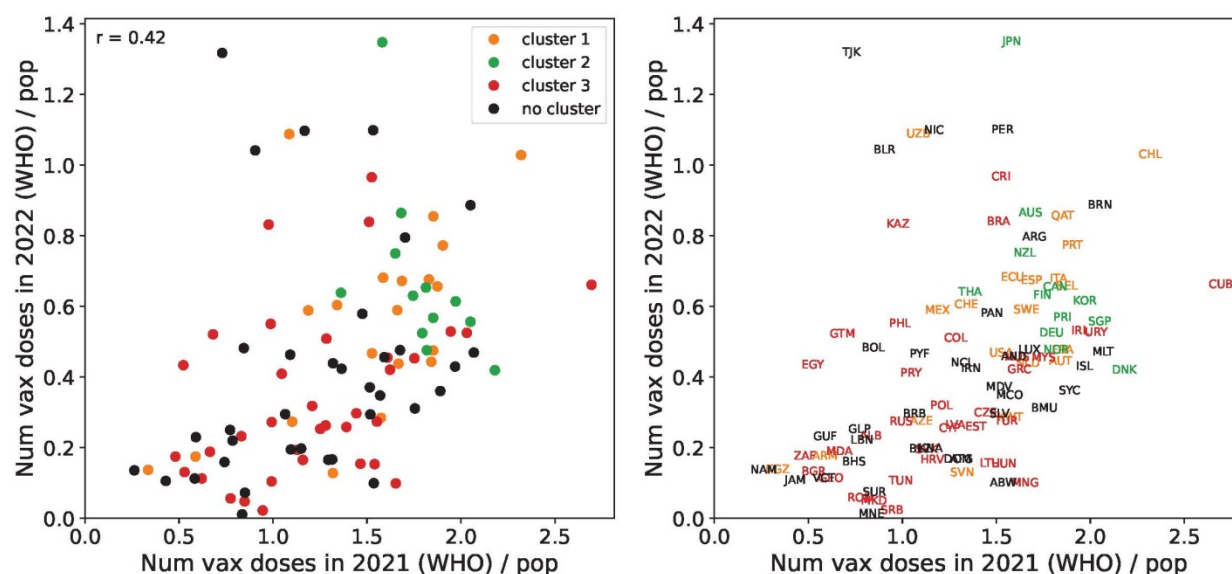
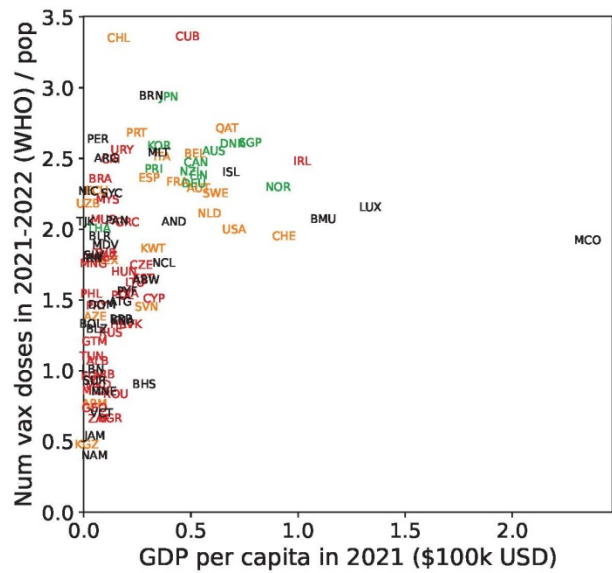
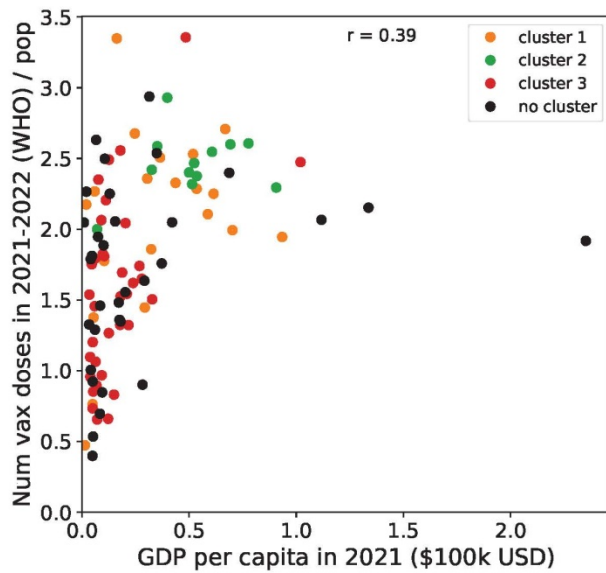
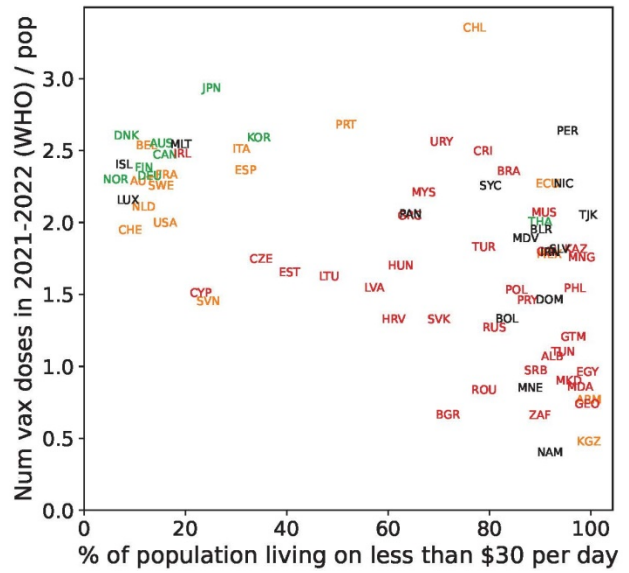
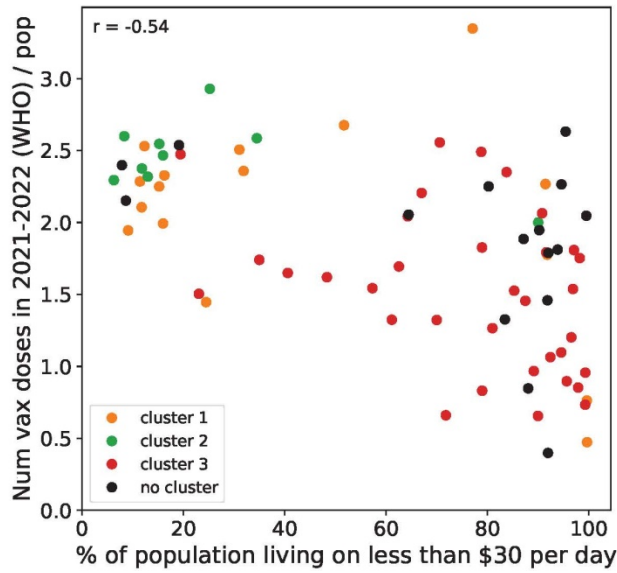


Figure 24. Number of vaccine injections given in 2022, per 2019 population, versus number of vaccine injections given in 2021, per 2019 population, as points (left panel) and for each country as labelled (right panel), using the WHO data on vaccination. The colours correspond to the three clusters from the cluster analysis. The Pearson correlation coefficient is $r = +0.42$.

The median values of number of vaccine injections per population are approximately 0.4 in 2022 and 1.5 in 2021, or 1.9 overall, and there are large country-to-country differences, from approximately 0.4 to approximately 3.0, on the two-year period.

The number of vaccine injections per population, 2021-2022 (WHO data), by country correlates with various socio-economic variables. This is illustrated in the four panels of Figure 25 for: share of population living on less than \$30 per day ($r = -0.54$), GDP per capita ($r = +0.39$), median income per day ($r = +0.51$), and life expectancy at age 65 ($r = +0.57$), as labelled.



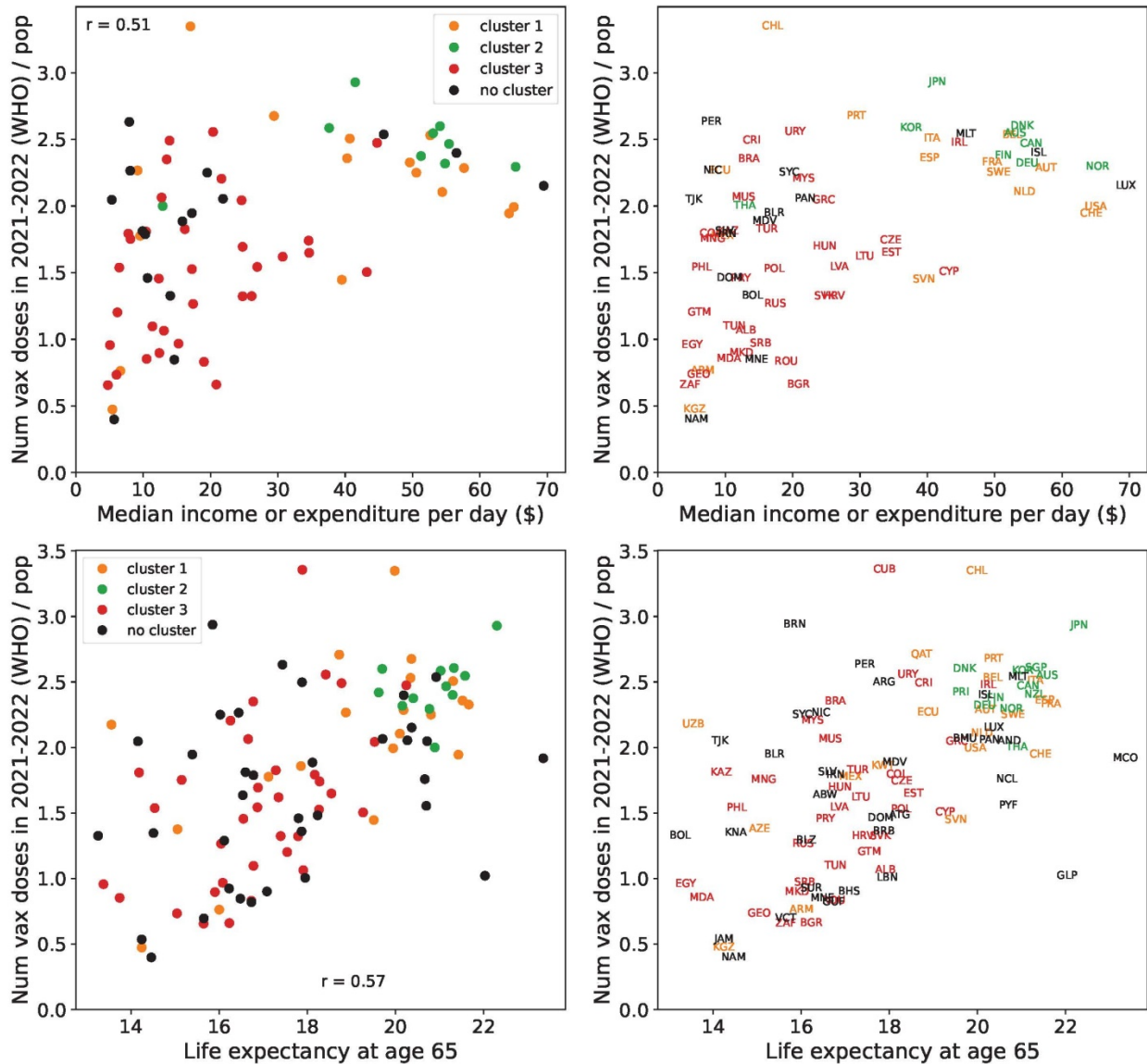


Figure 25. Number of vaccine injections given in 2021-2022 (WHO data), per 2019 population, as points (left panel) and for each country as labelled (right panel) versus: share of population living on less than \$30 per day ($r = -0.54$), GDP per capita ($r = +0.39$), median income per day ($r = +0.51$), and life expectancy at age 65 ($r = +0.60$), as labelled in the separate twin panels. The colours correspond to the three clusters from the cluster analysis.

Therefore, corresponding due care must be taken in interpreting correlations between excess all-cause mortality and degree of vaccination.

4.15 Excess all-cause mortality (as % of expected mortality) correlations with socio-economic variables

In examining possible relations or correlations between excess all-cause mortality and socio-economic variables (by country), two considerations, in particular, are important: First, the time period of integration of the excess all-cause mortality, since the correlation can vary significantly depending on the chosen time period; and second, the possible correlations between the socio-economic variables themselves, since these are not necessarily (or usually) independent variables.

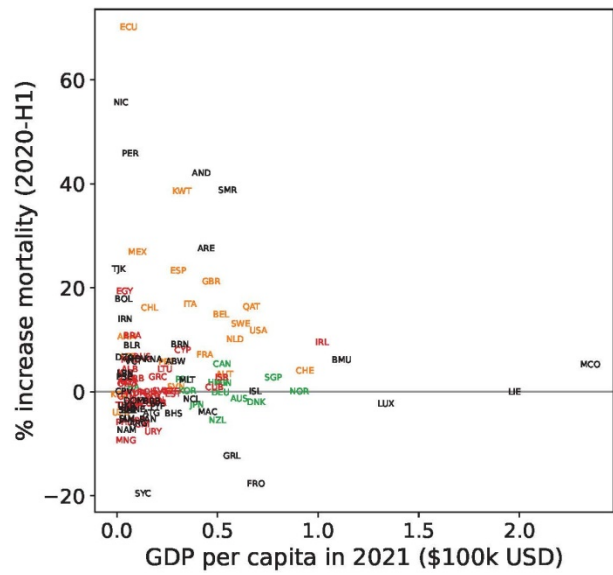
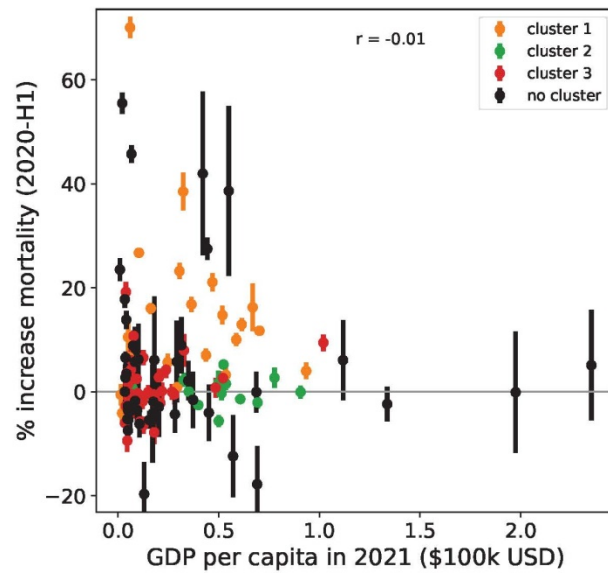
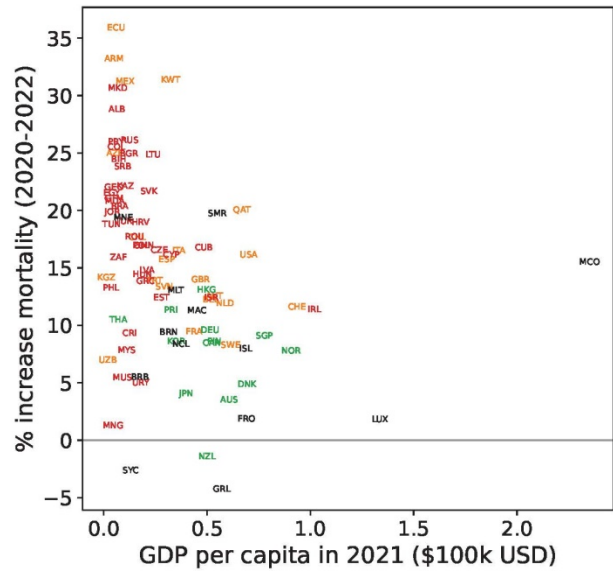
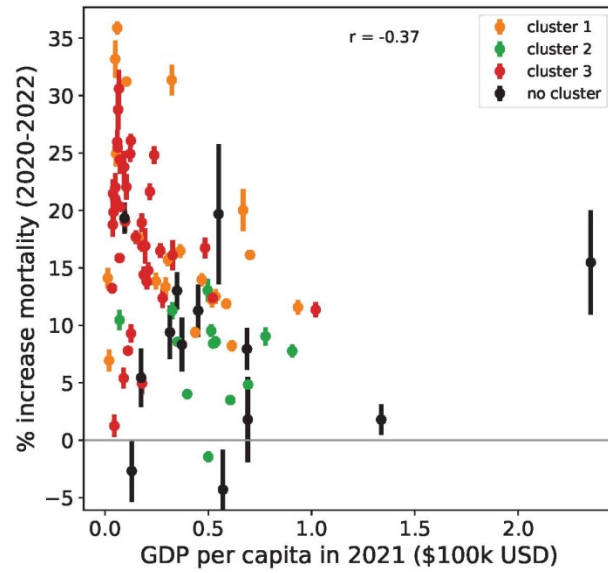
The dependent variables (outcomes) are taken to be the excess all-cause mortality, by country, for the time periods of integration: Covid period (2020 through 2022 or 2020 through 2023-H1), and the half years 2020-H1 to 2023-H1.

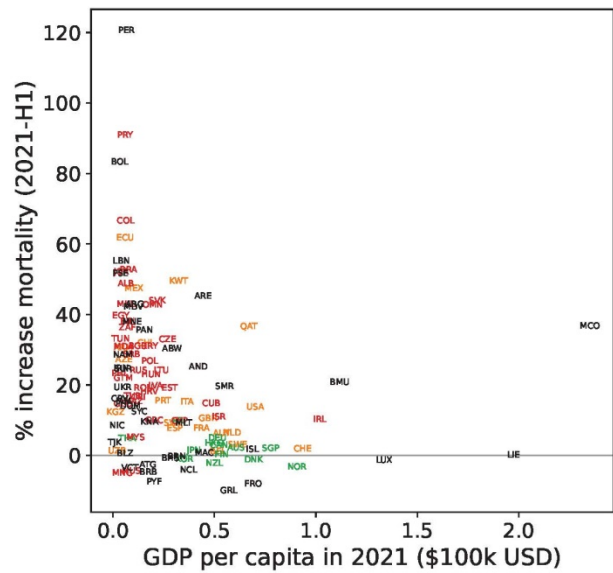
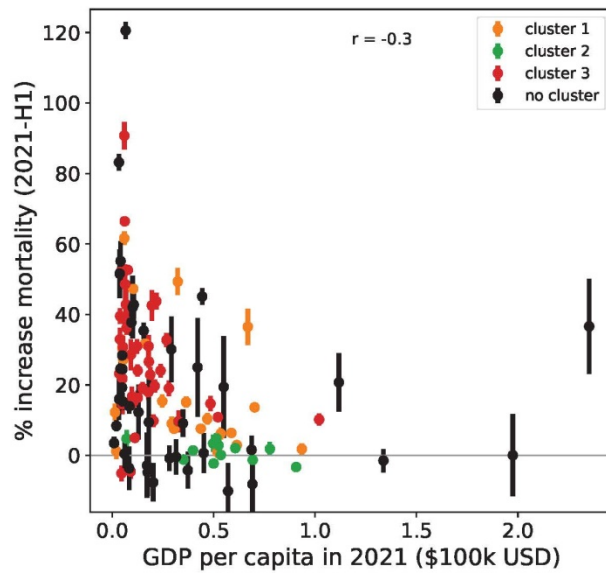
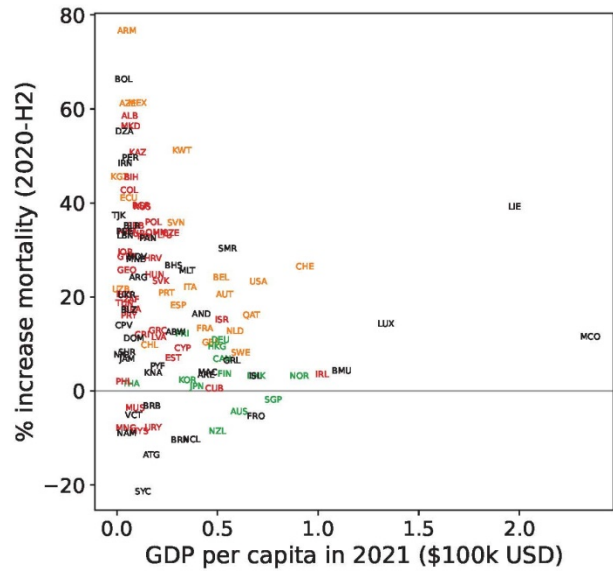
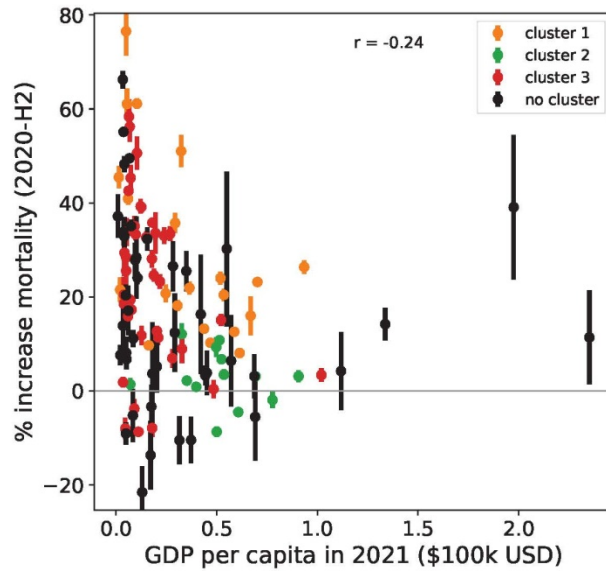
The socio-economic variables of the countries are from any convenient and reliable year near 2020, usually 2019.

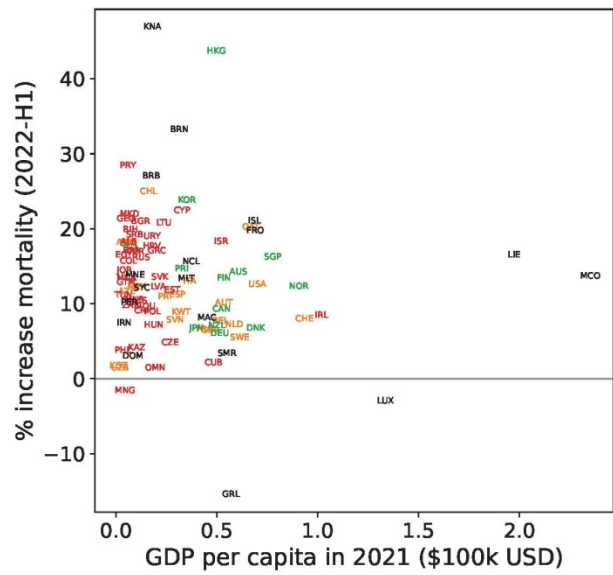
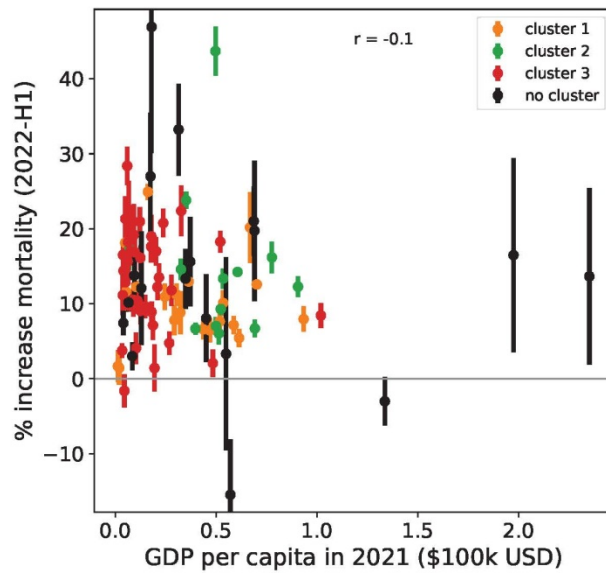
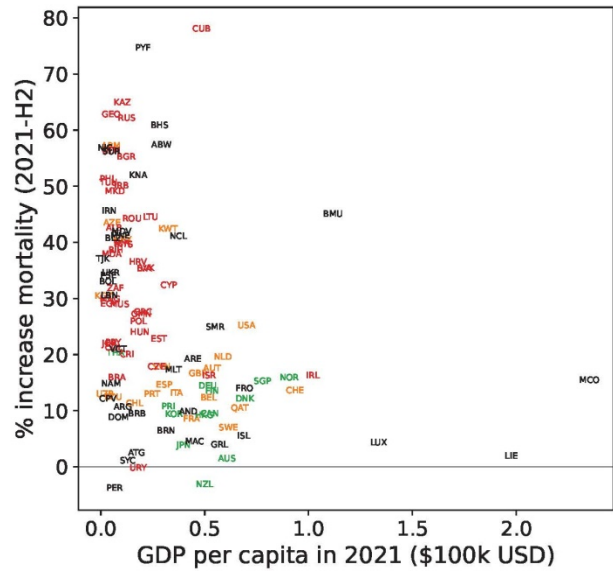
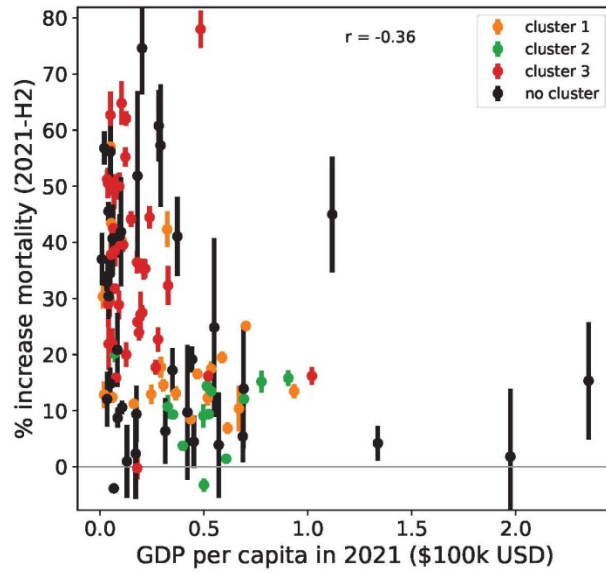
An examination of inter-socio-economic variable relations is presented in the figure of **Appendix F**. Likewise; a table of the corresponding Pearson correlation coefficients is given in **Appendix G**. We see, therefore, unsurprisingly, for example, that all the socio-economic variable that quantify poverty or wealth of residents are all highly correlated between themselves, to different degrees, and with different functional dependencies on each other. The correlations between poverty/wealth indicators and age structure of the population or income inequality (Gini) are not as strong, suggesting quasi-independence or relational complexity between these types of variables (poverty/wealth vs age structure; and poverty/wealth vs income inequality).

The main results of the correlations between excess all-cause mortality during the Covid period and socio-economic variables are shown in the figures below, for GDP per capita, Gini inequality index, share of population living on less than \$5.50 per day, share of population living on less than \$30 per day, median income per day, life expectancy at

age 65, share of population aged 60+, and share of population aged 90+. In each case, the excess all-cause mortality is for the Covid period itself (2020-2022) and for each half year in the Covid period, 2020-H1 to 2023-H1, and is expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (this percentage has been referred to as the “P-score”, Aron et al., 2020, Msemburi et al., 2023). Here, 2023-H1 is for the actual calendar half year, unlike 2023-H1*. The nominal Covid period 2020-2022 and the different half years include different numbers of points (countries), depending on availability of mortality data for each half year. A table of the corresponding Pearson correlation coefficients is in **Appendix H**.







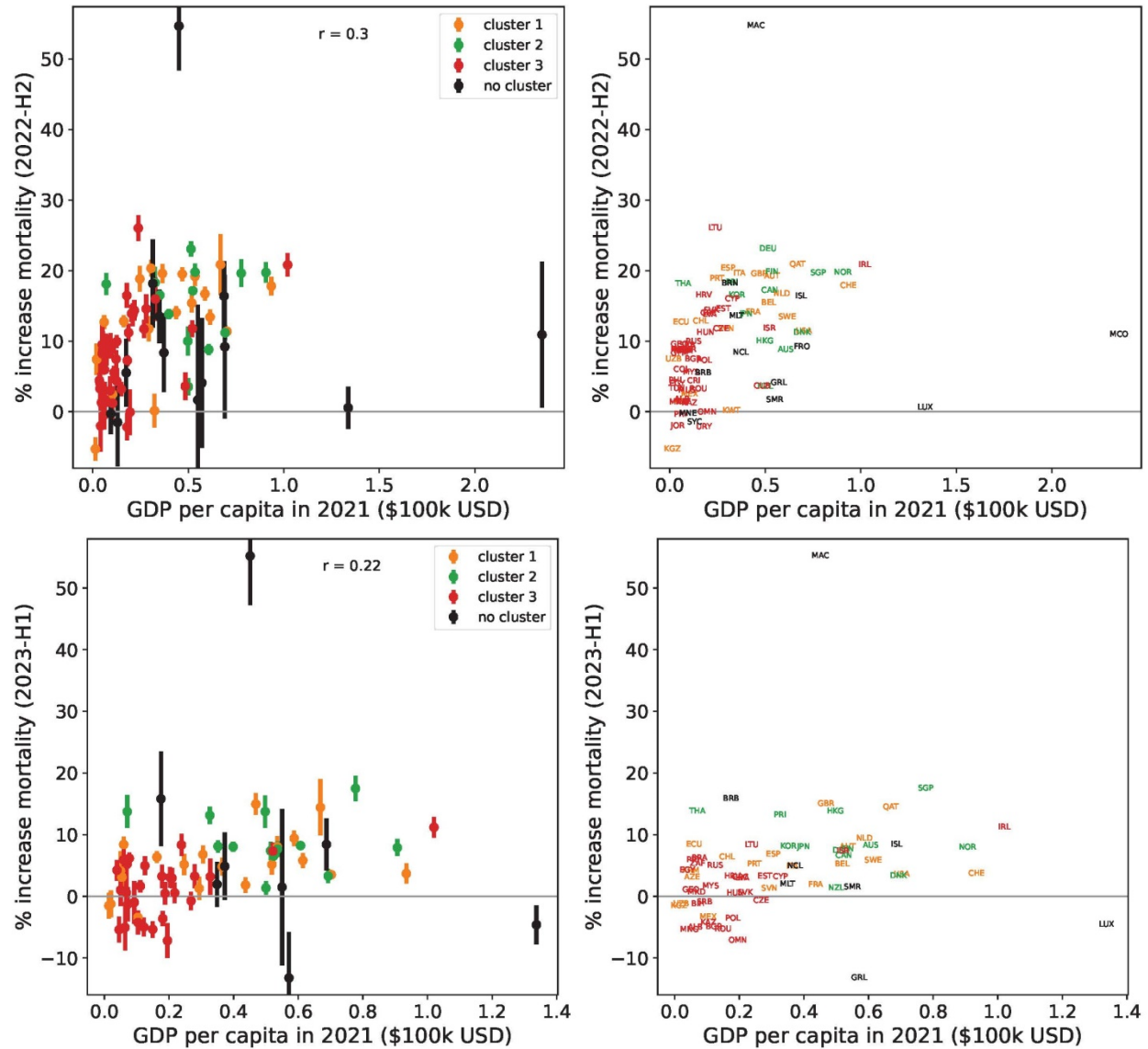
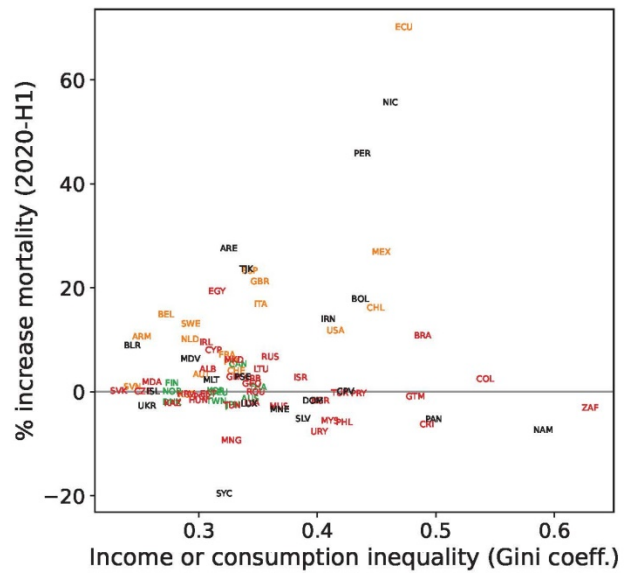
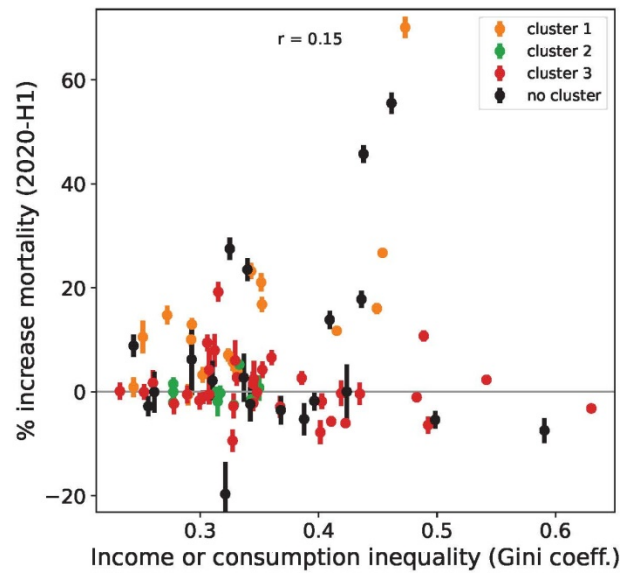
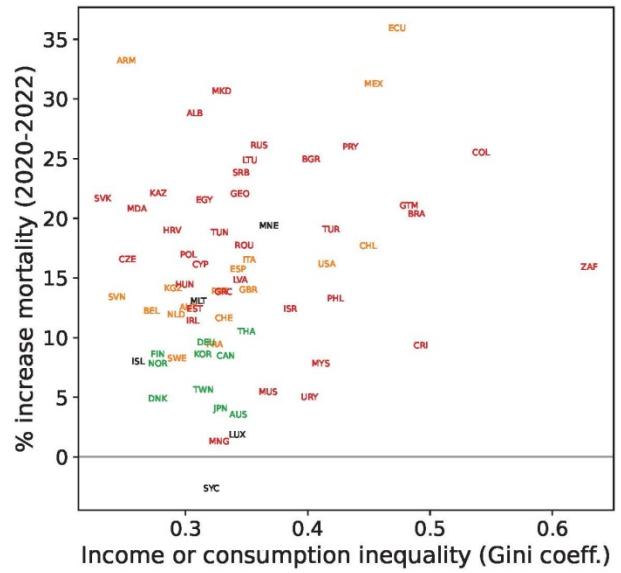
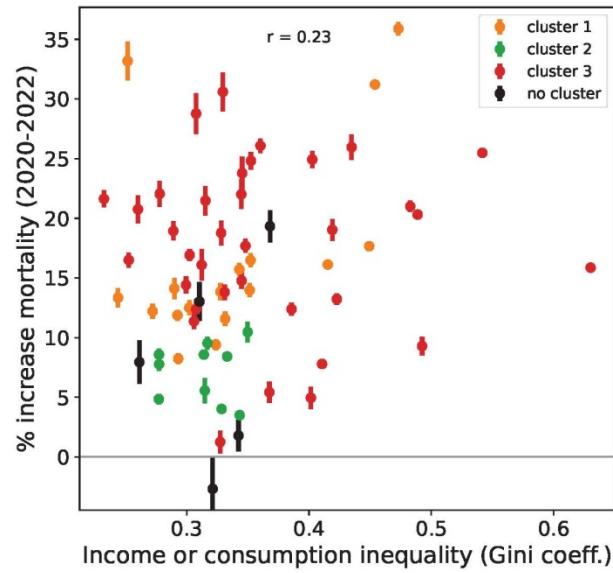
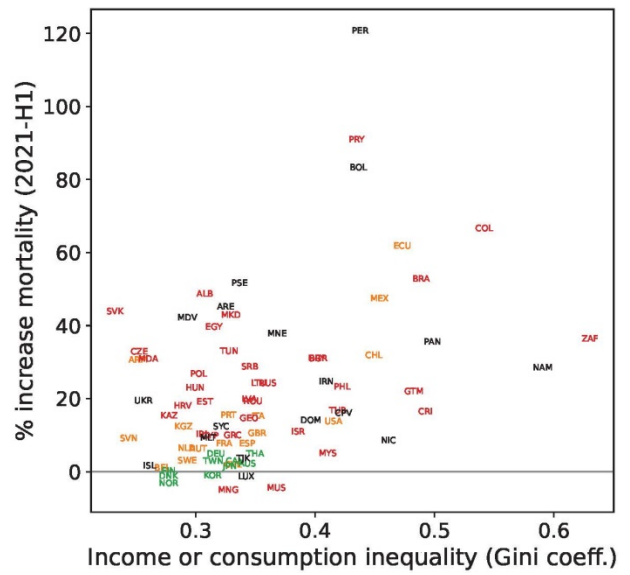
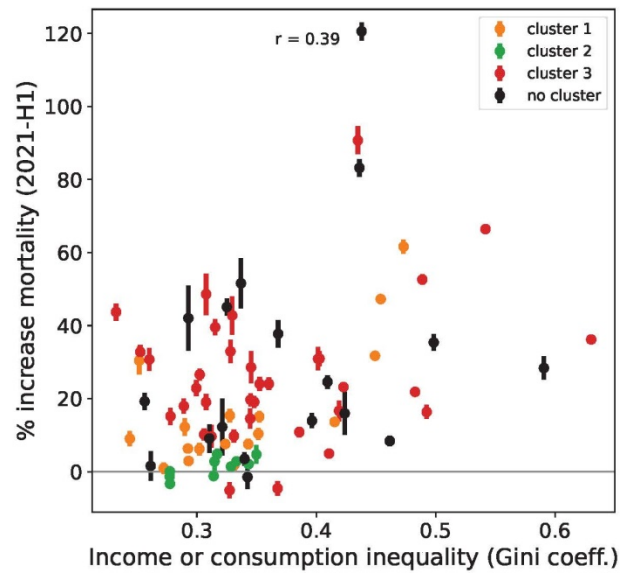
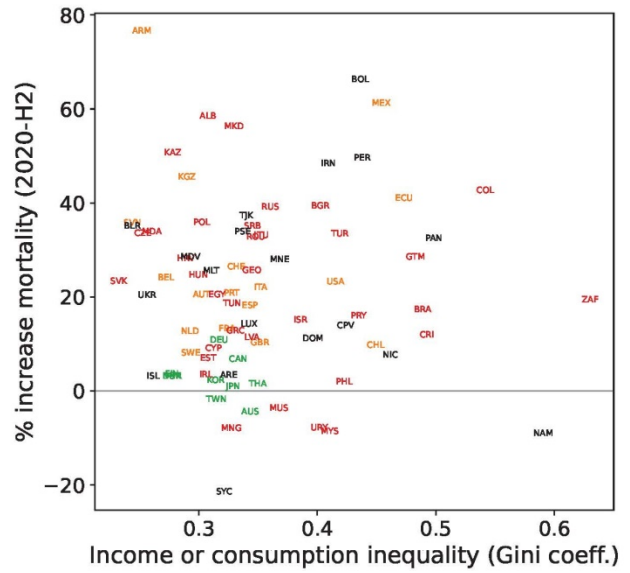
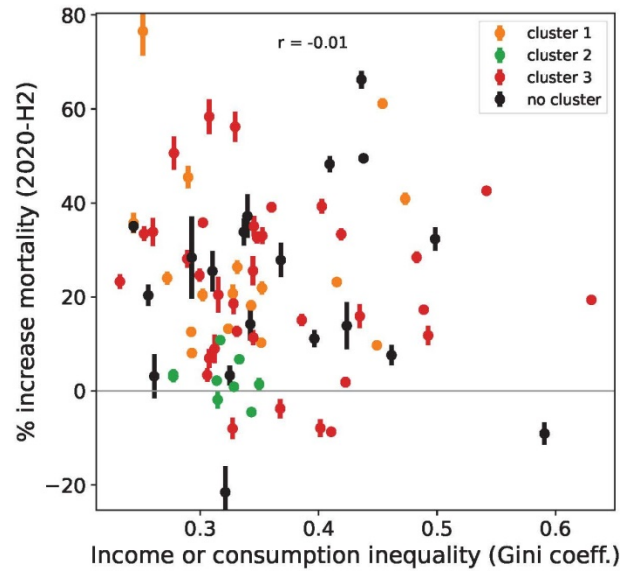
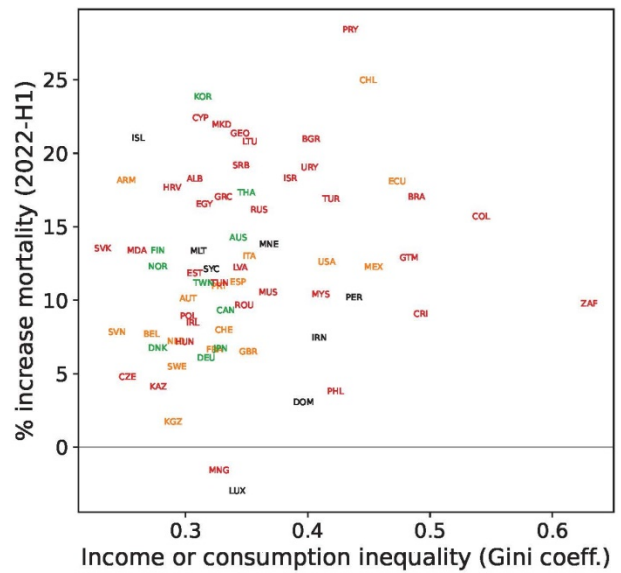
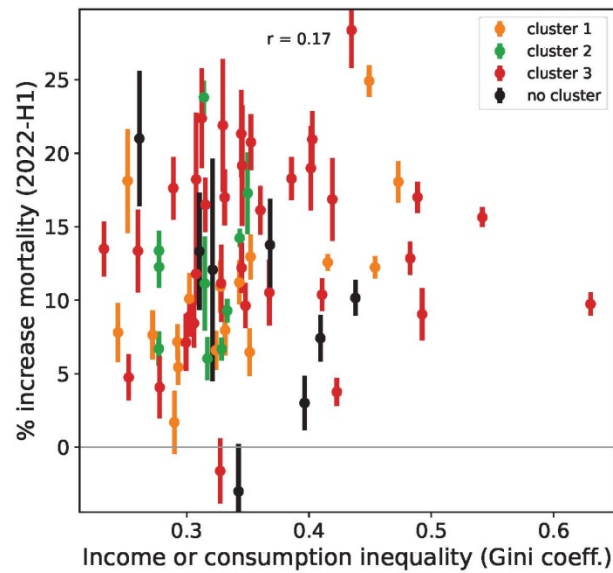
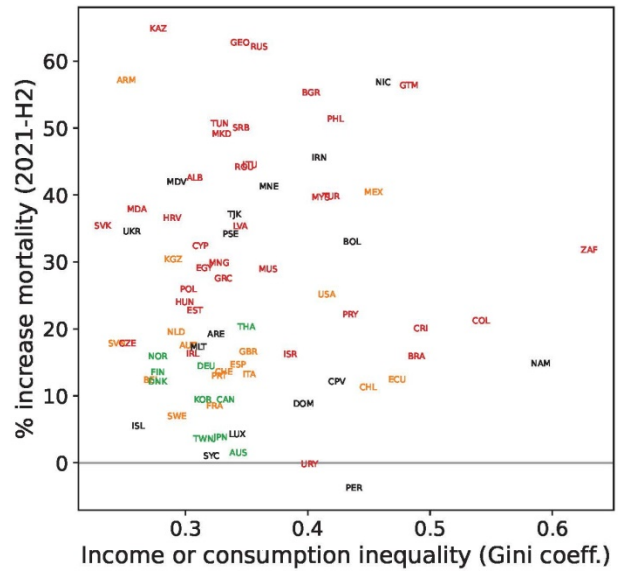
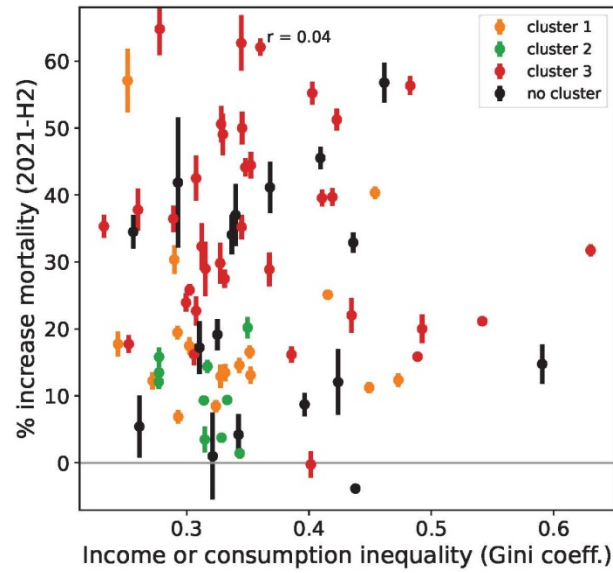


Figure 26. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus GDP per capita, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







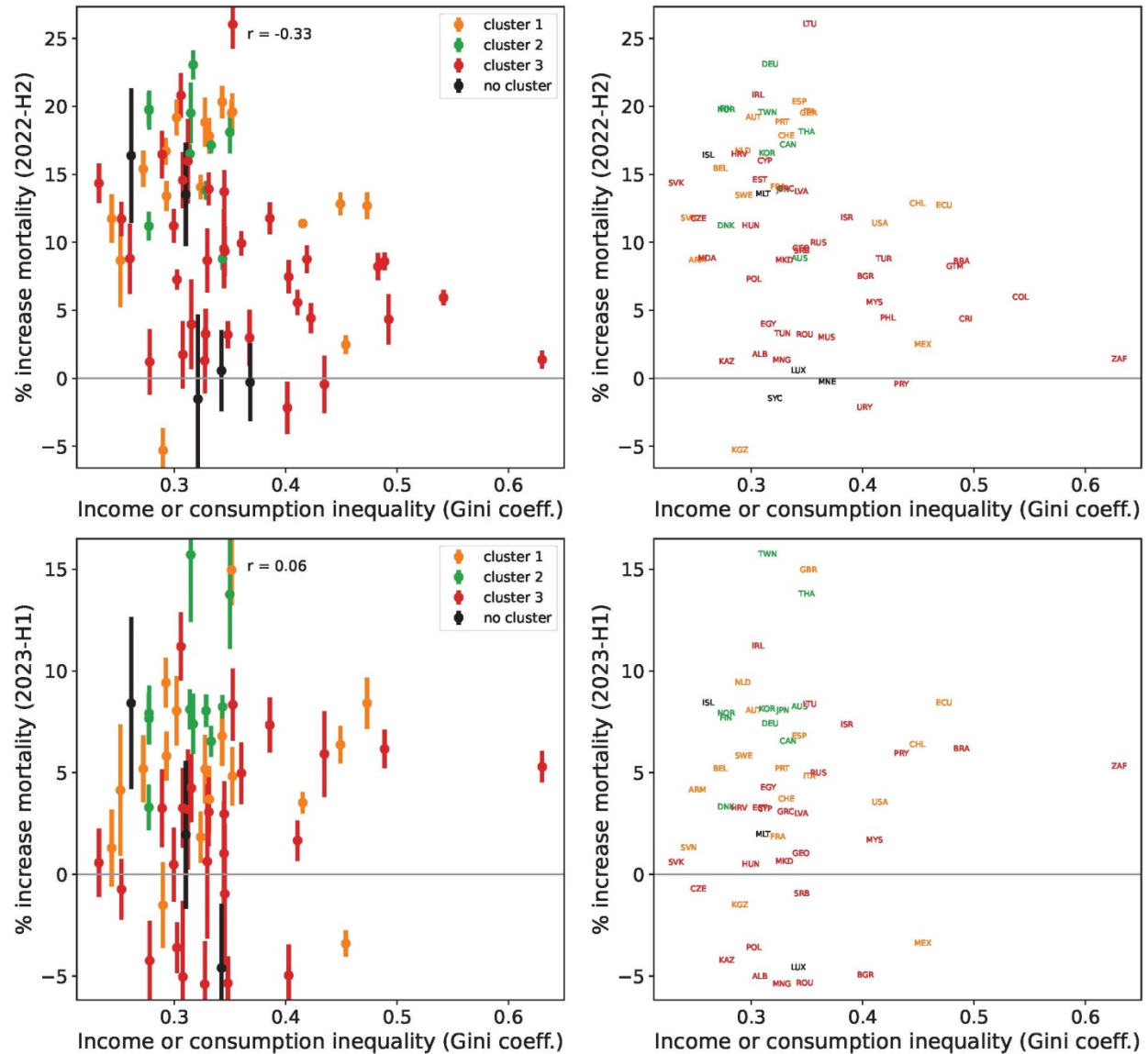
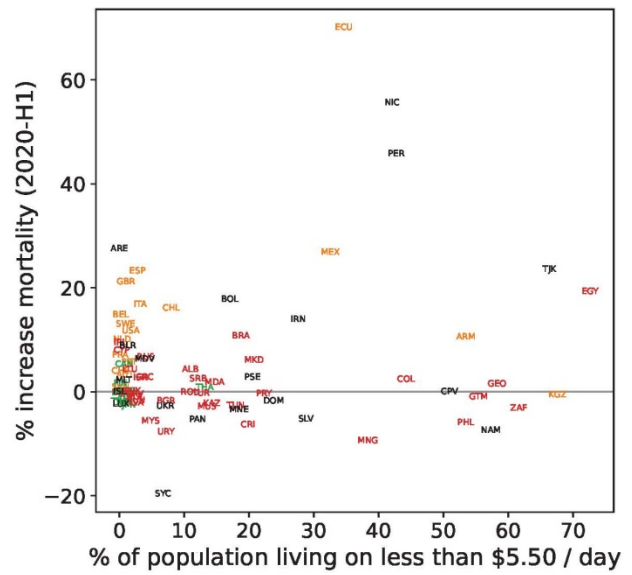
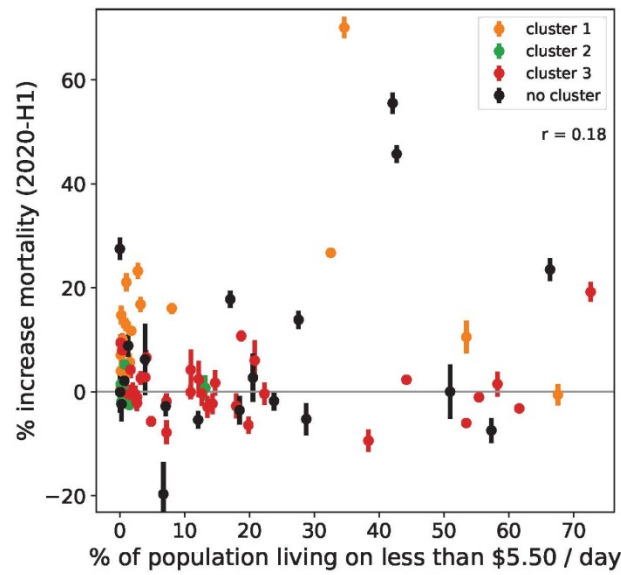
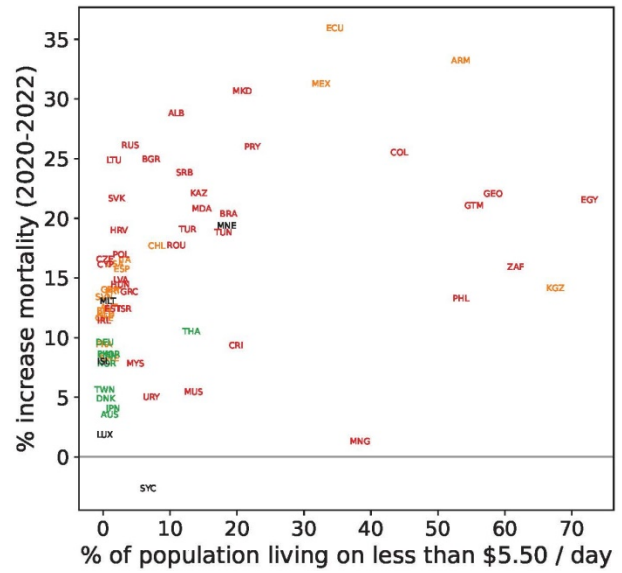
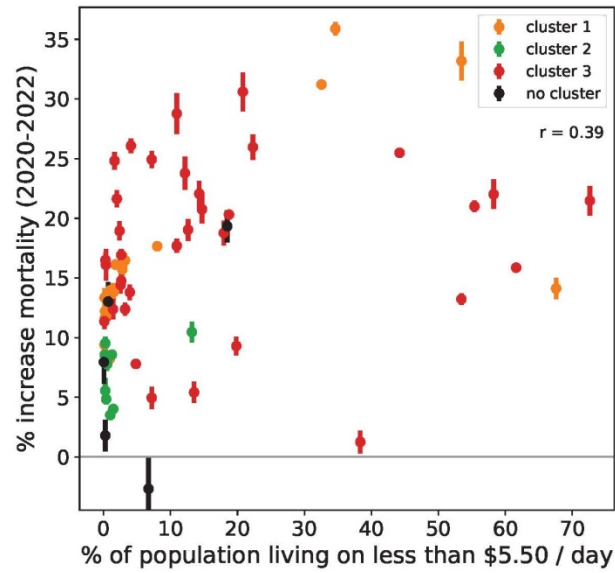
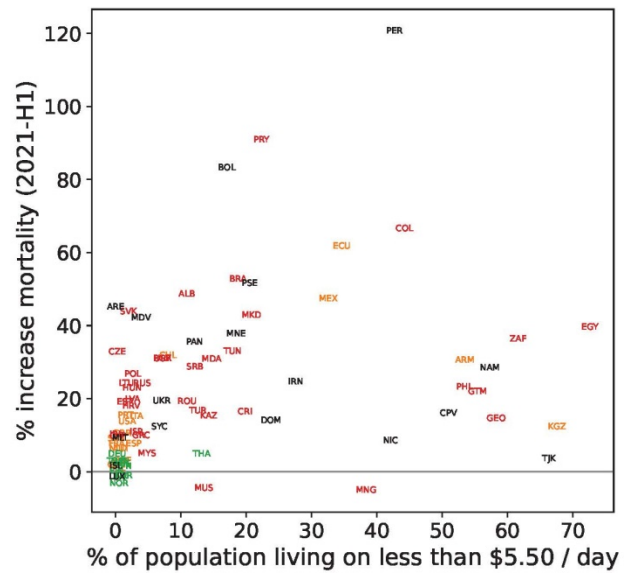
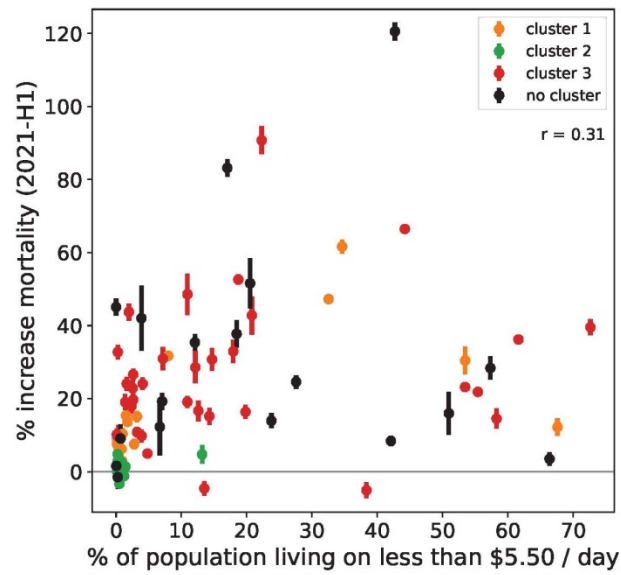
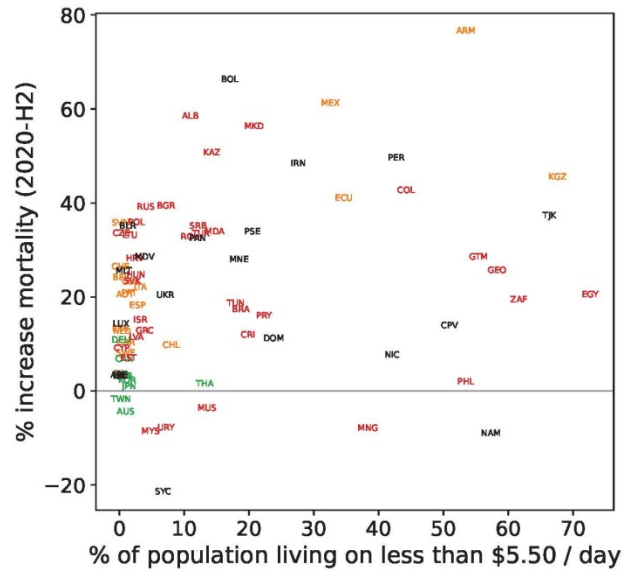
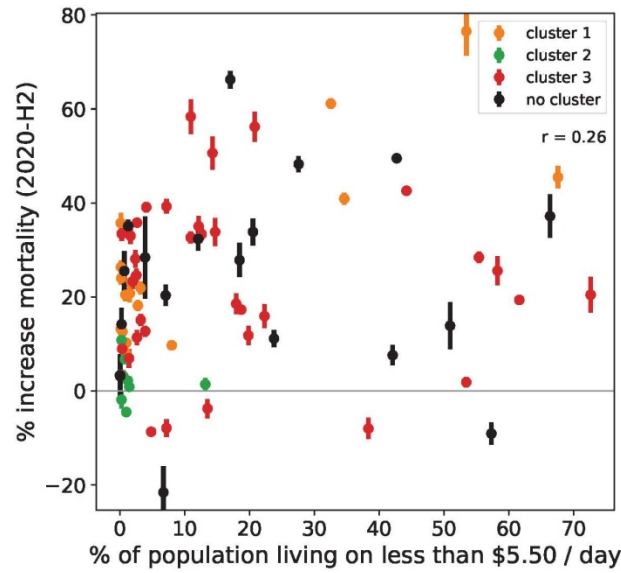
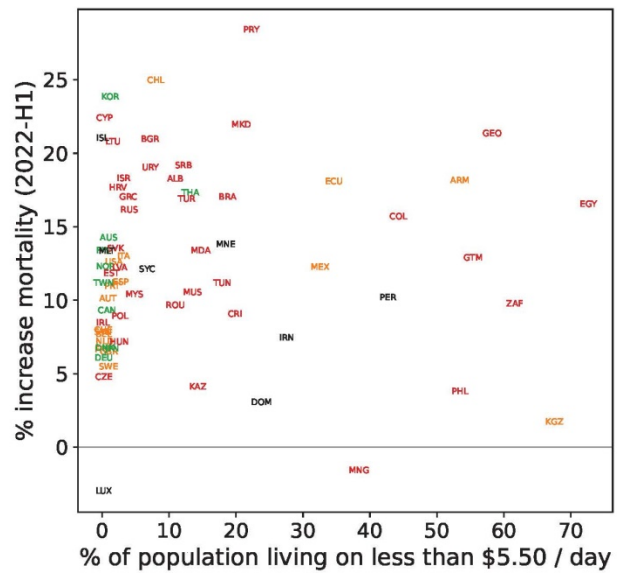
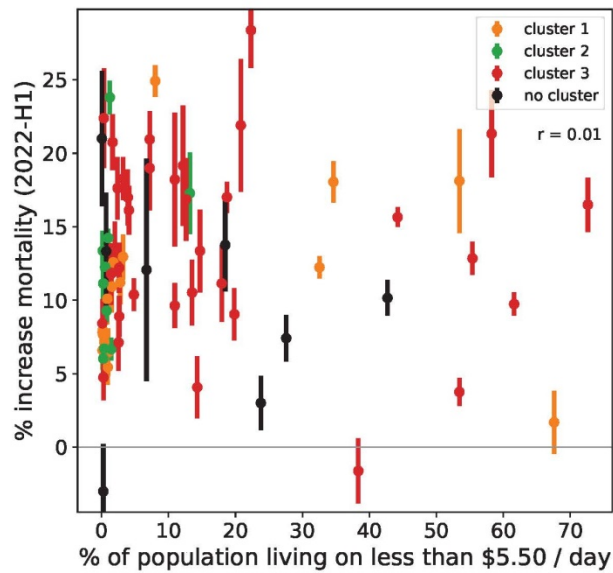
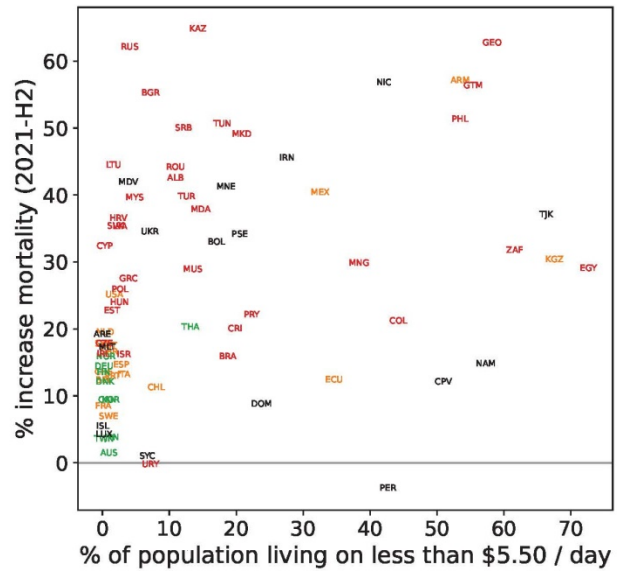
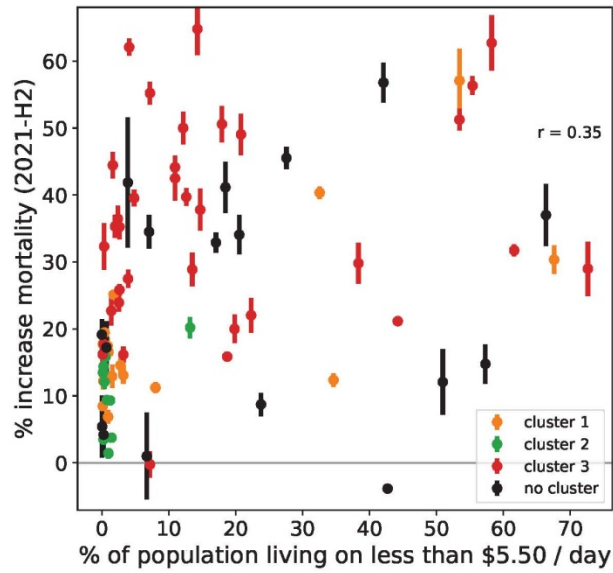


Figure 27. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus Gini inequality index, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







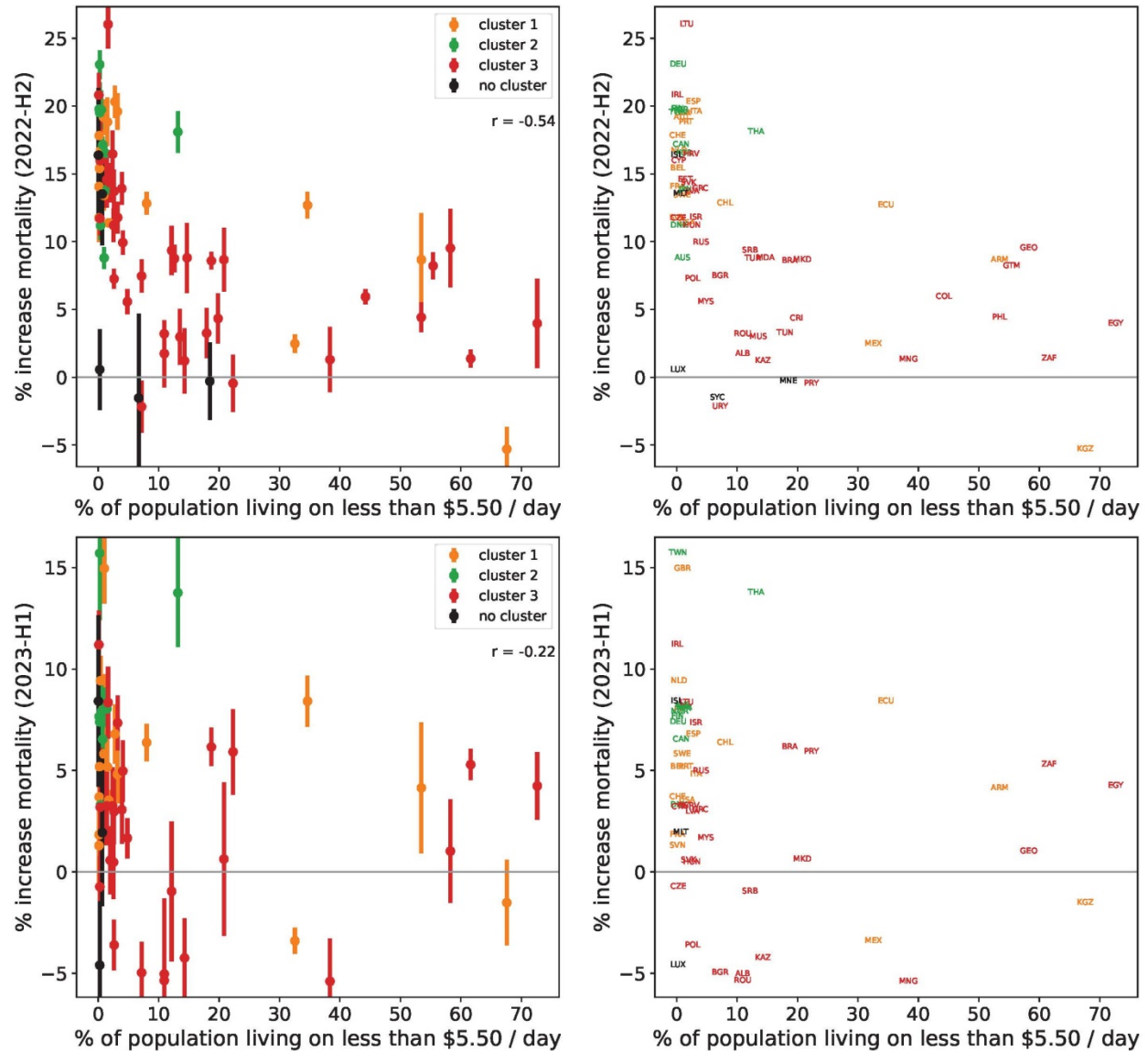
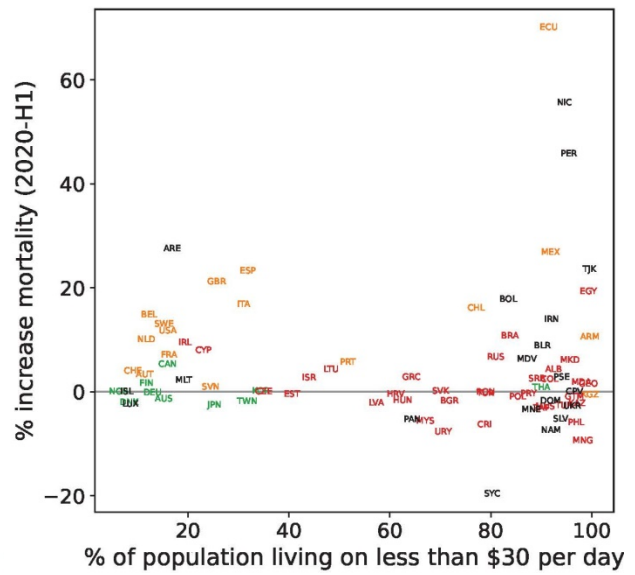
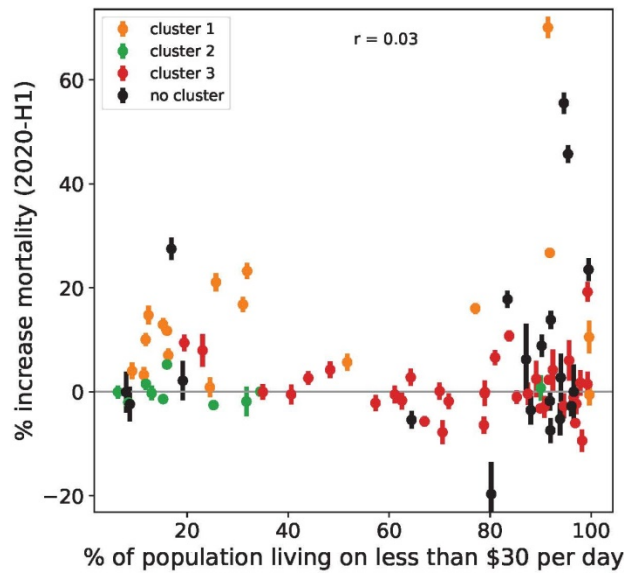
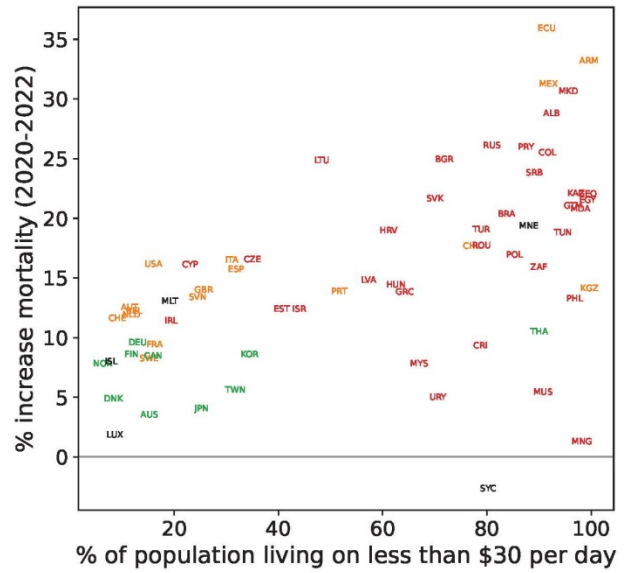
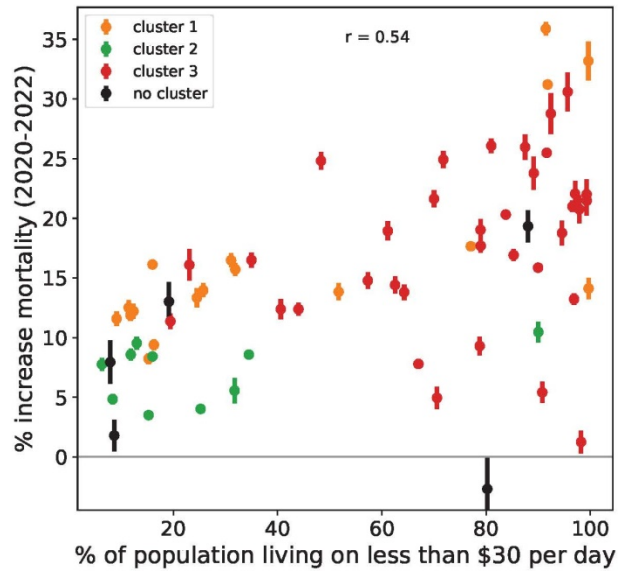
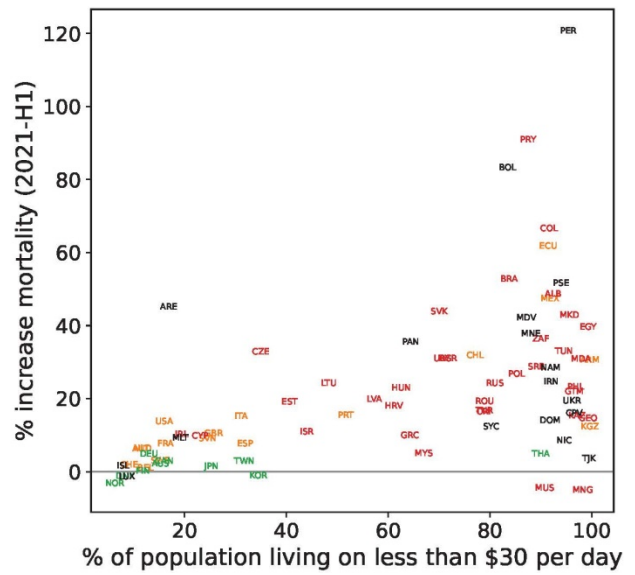
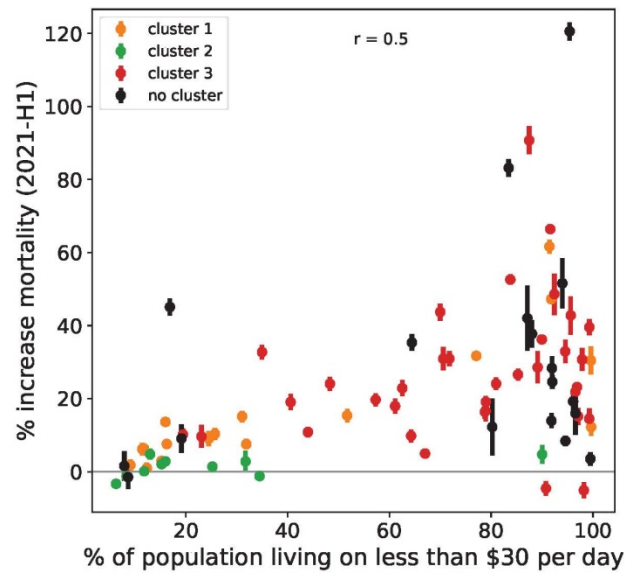
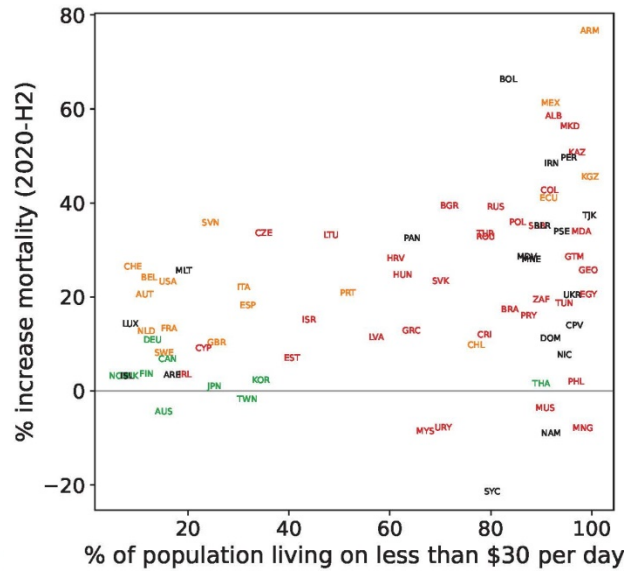
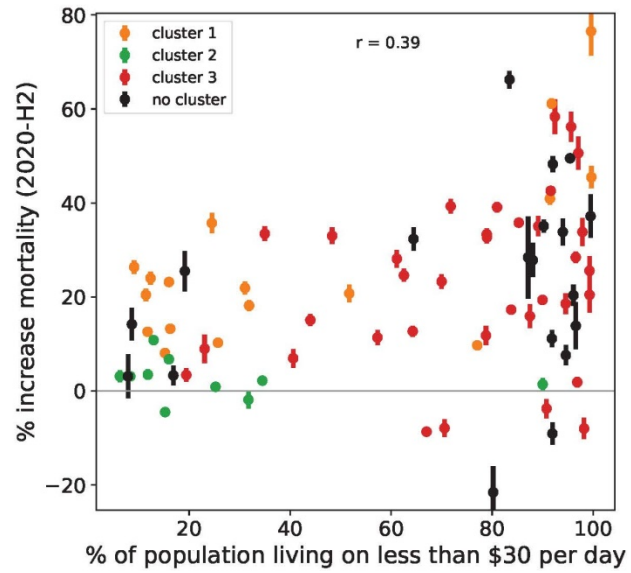
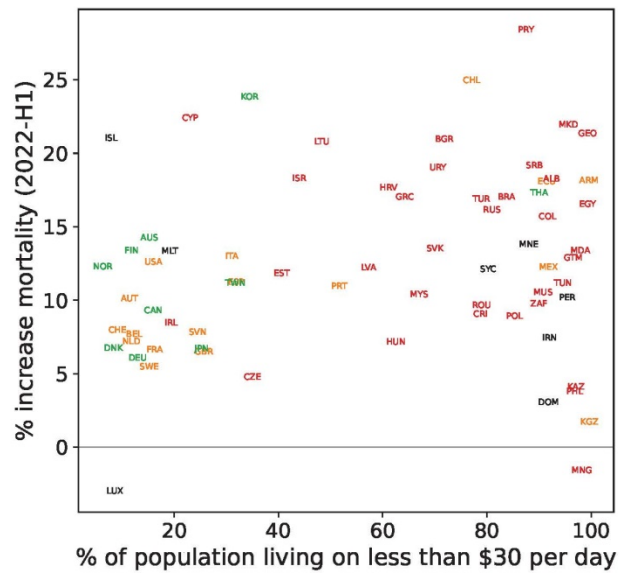
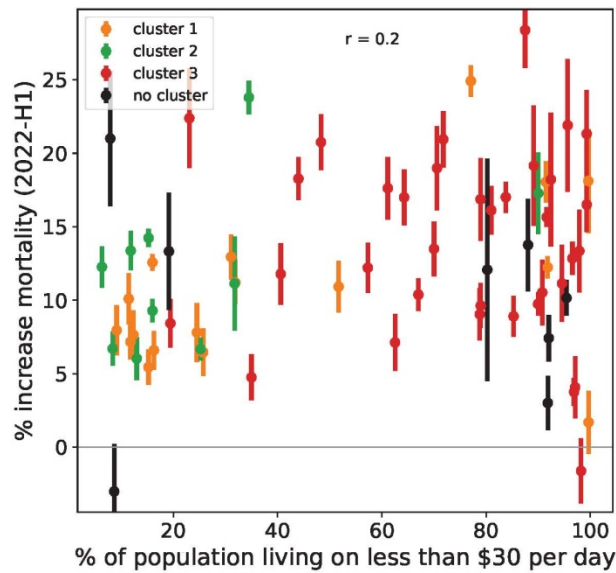
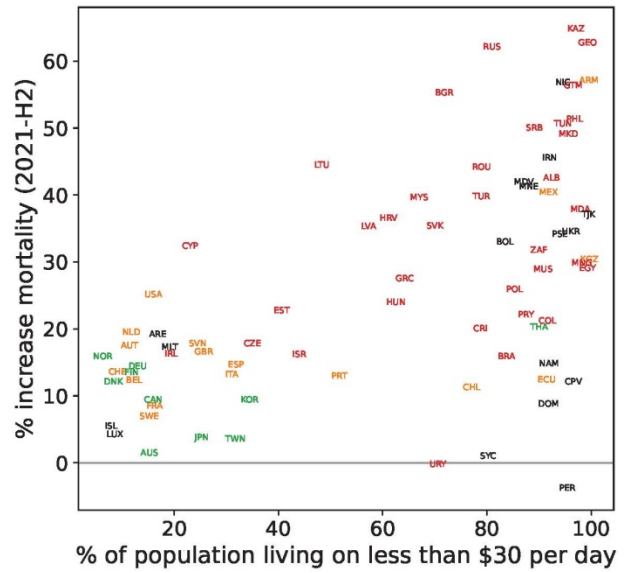
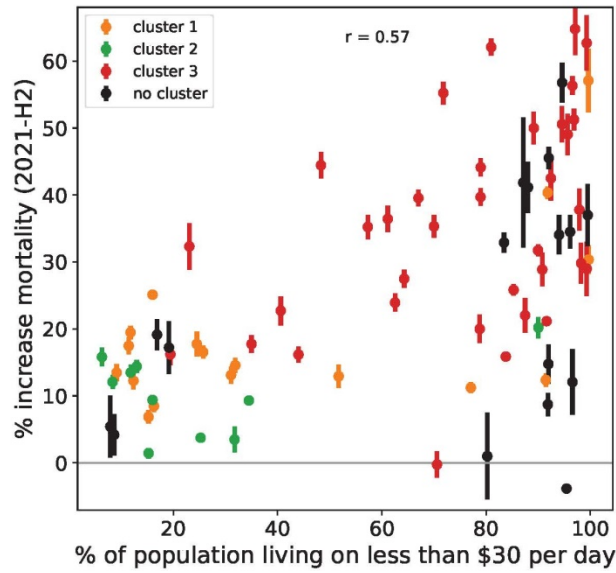


Figure 28. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus share of population living with less than \$5.50 per day, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







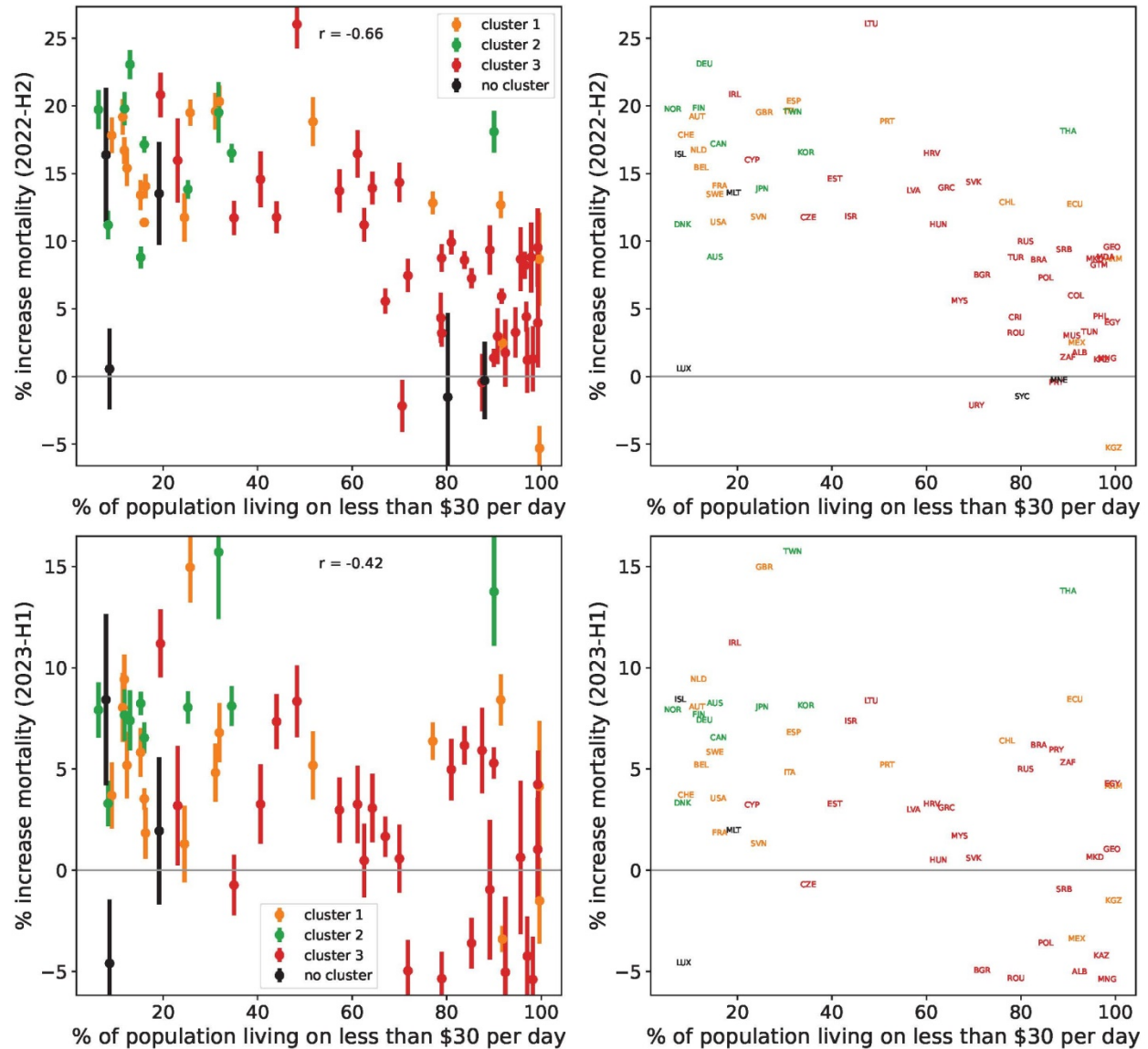
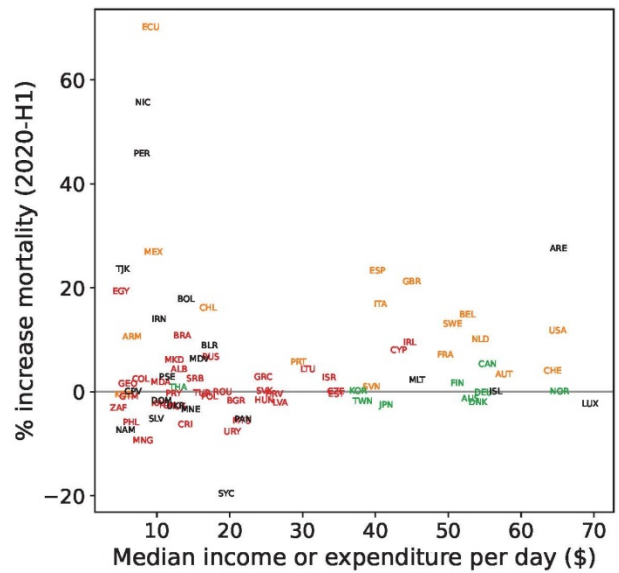
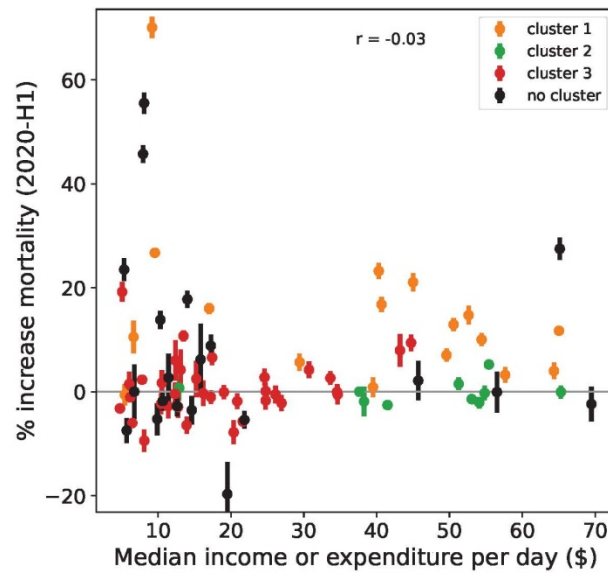
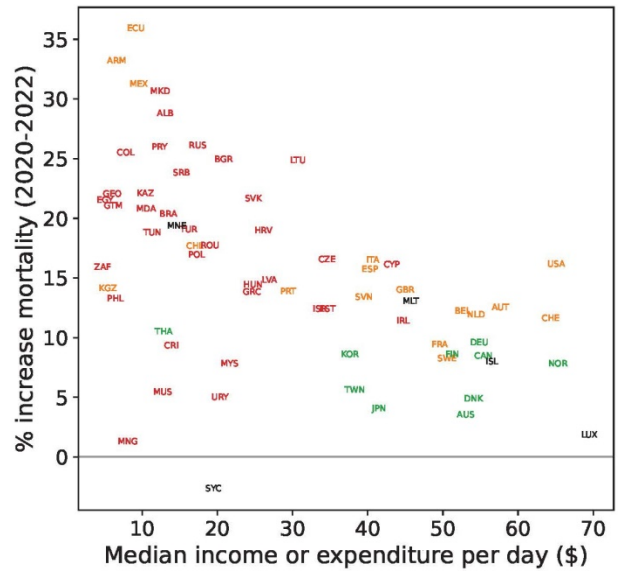
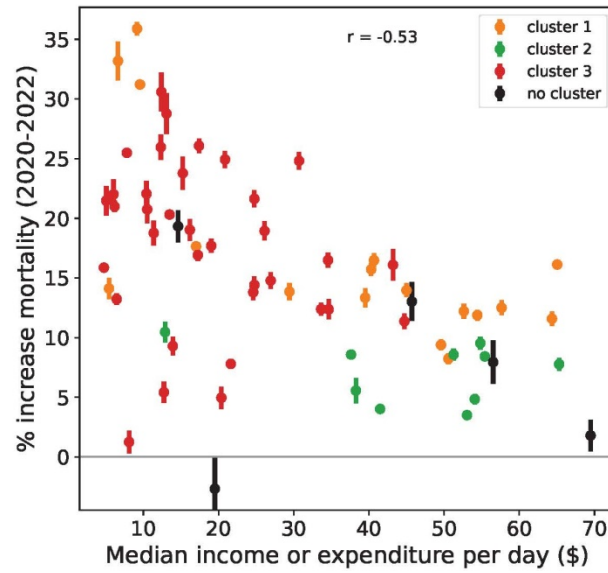
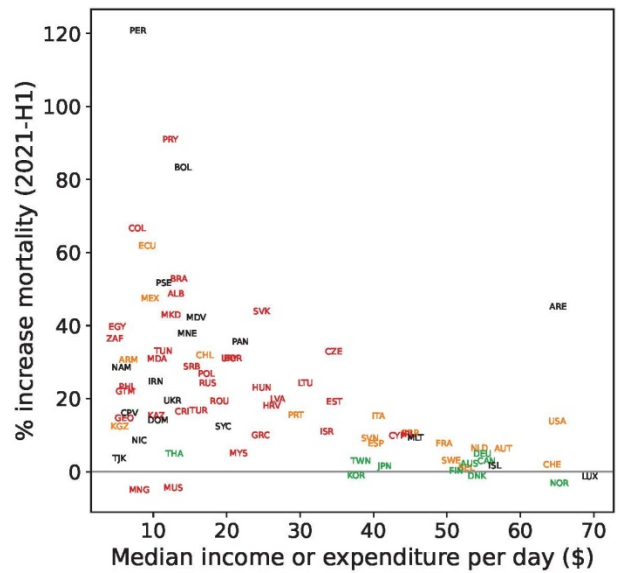
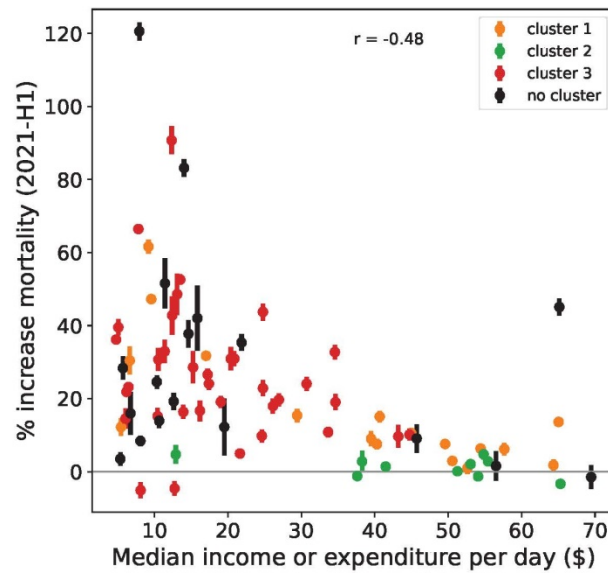
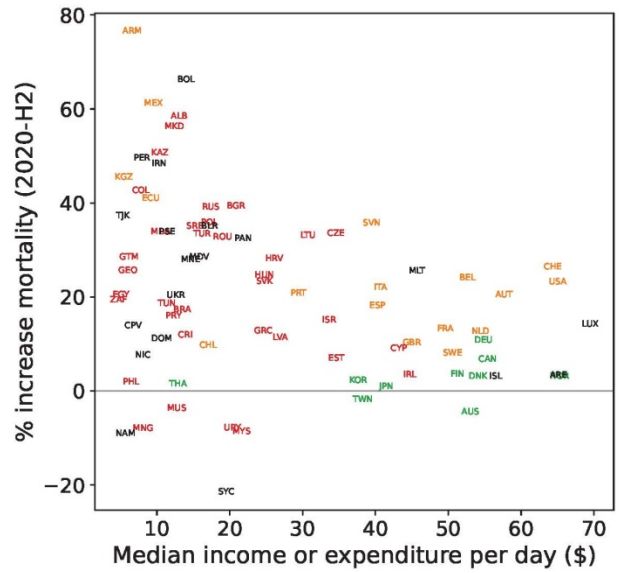
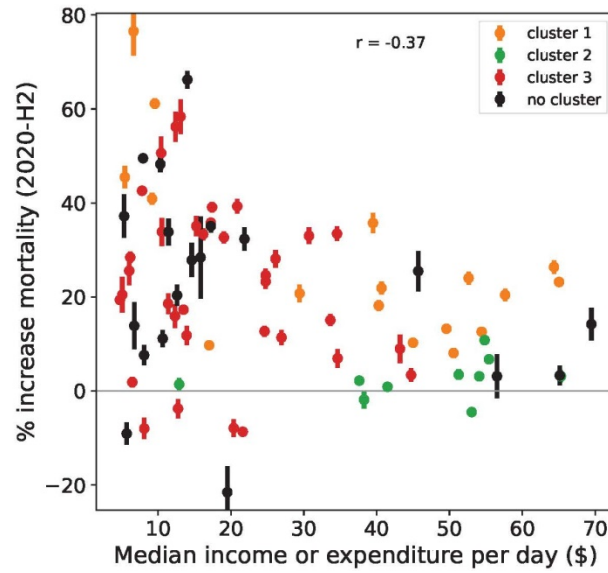
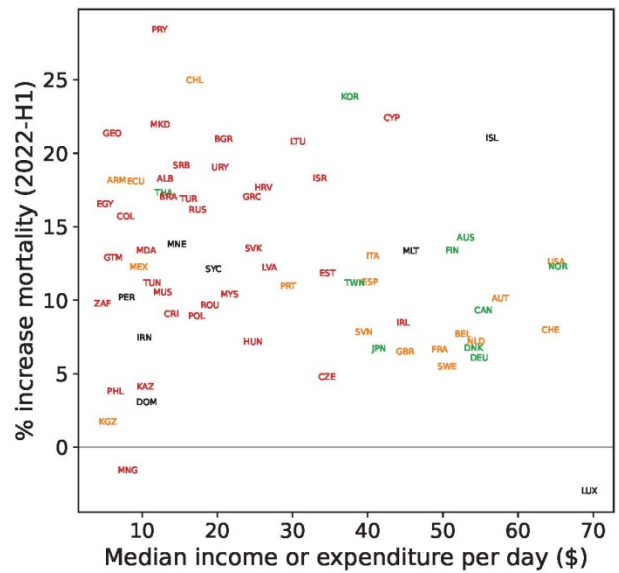
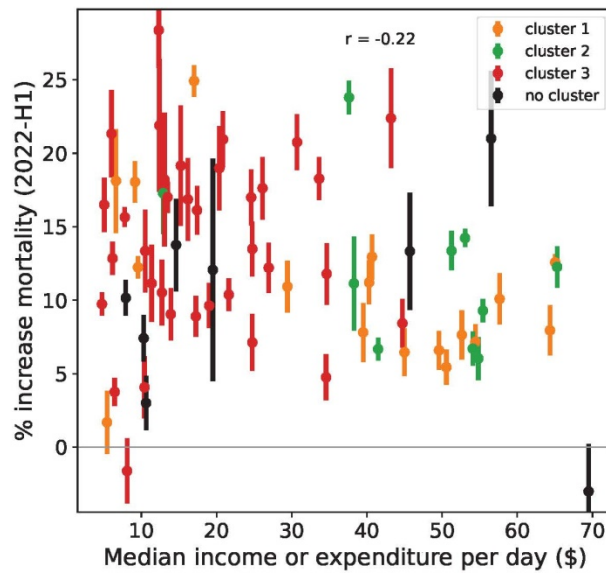
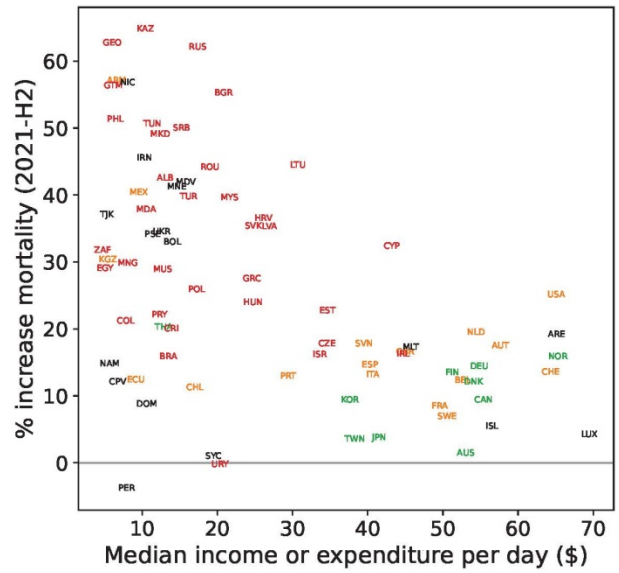
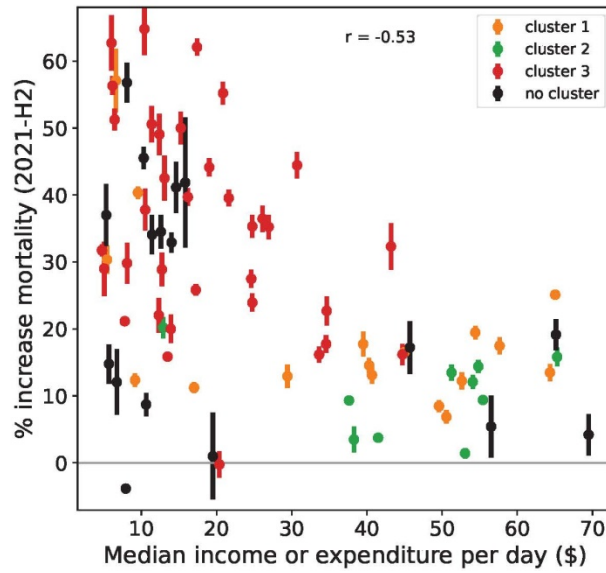


Figure 29. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus share of population living with less than \$30 per day, with 1 σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







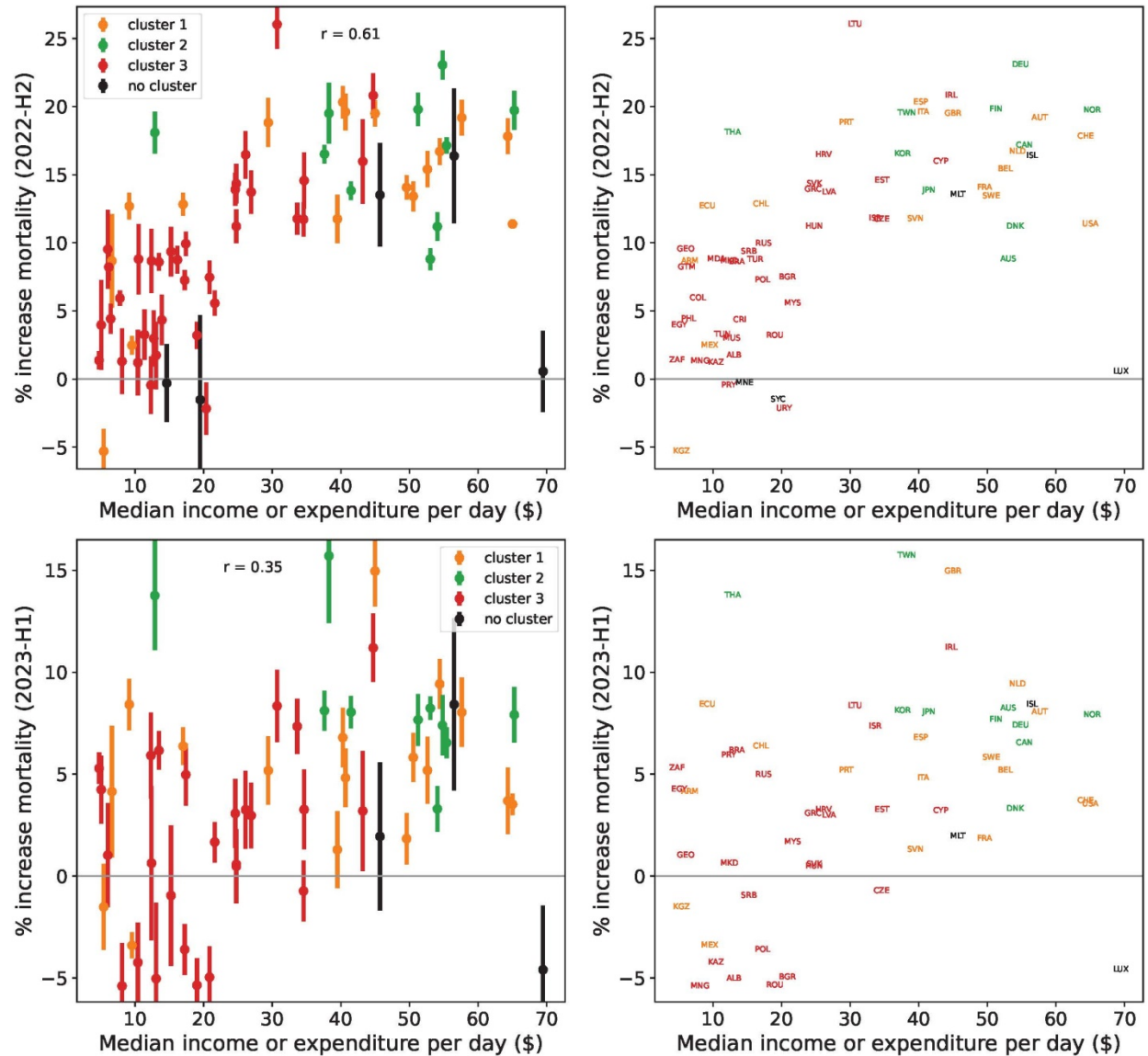
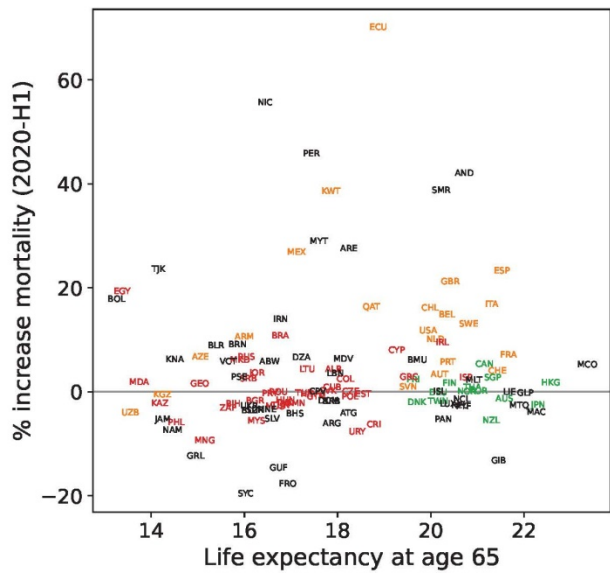
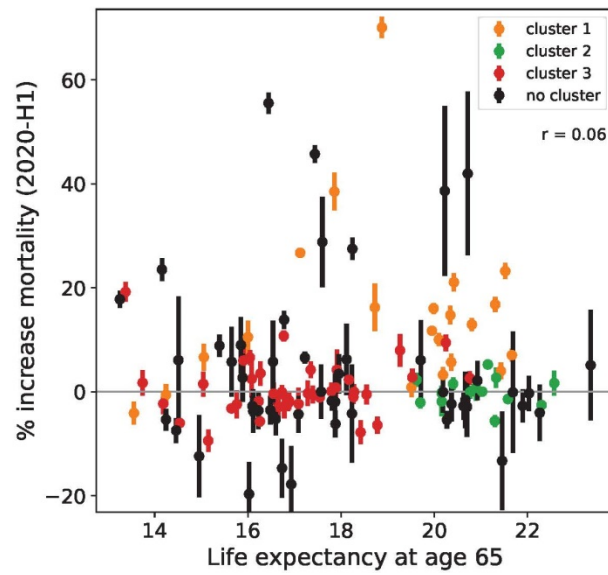
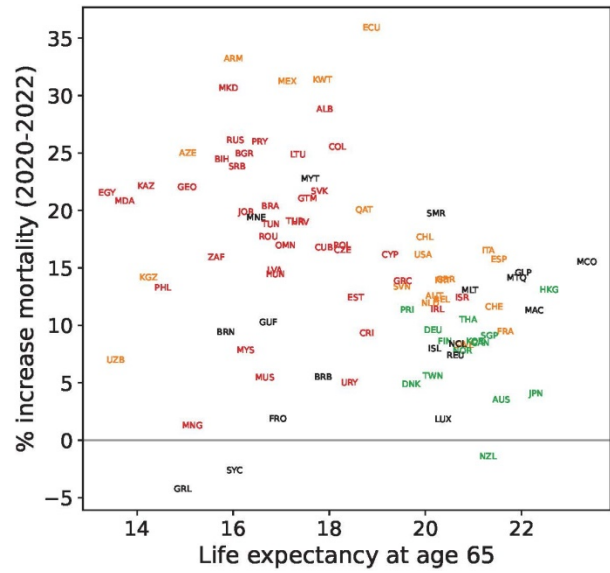
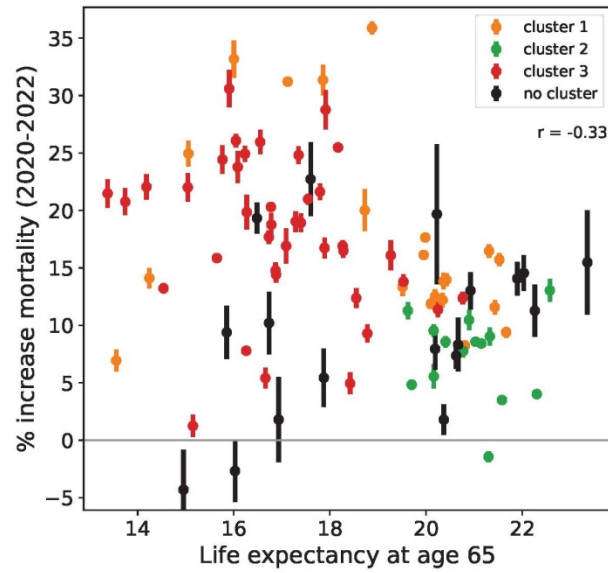
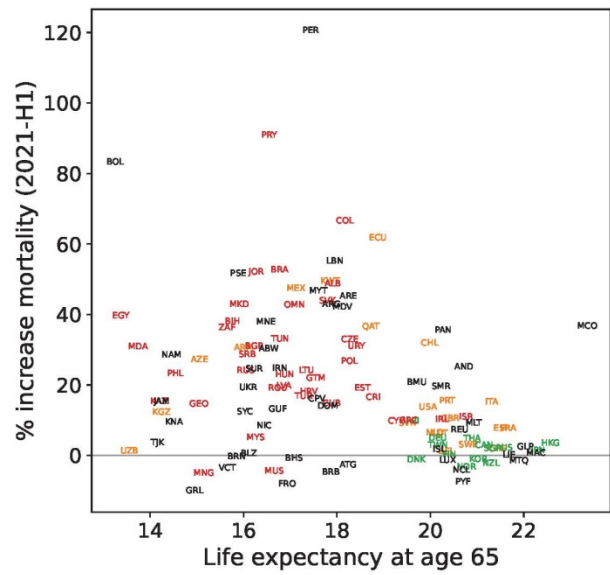
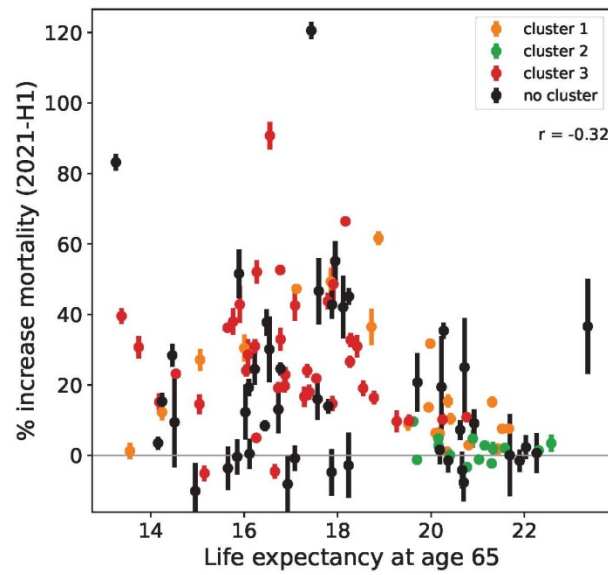
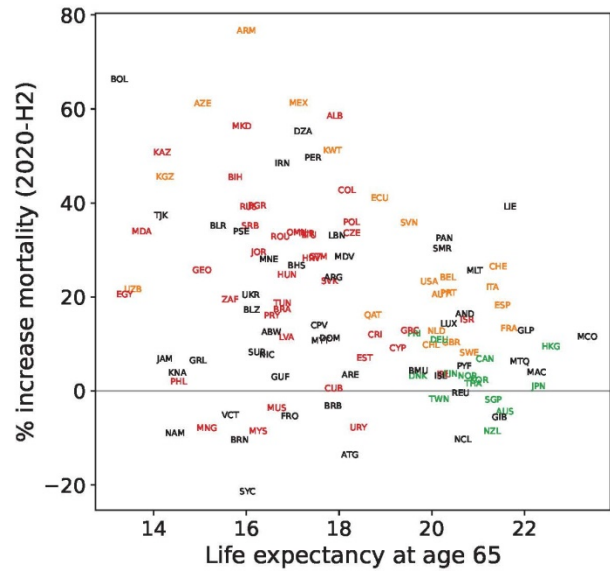
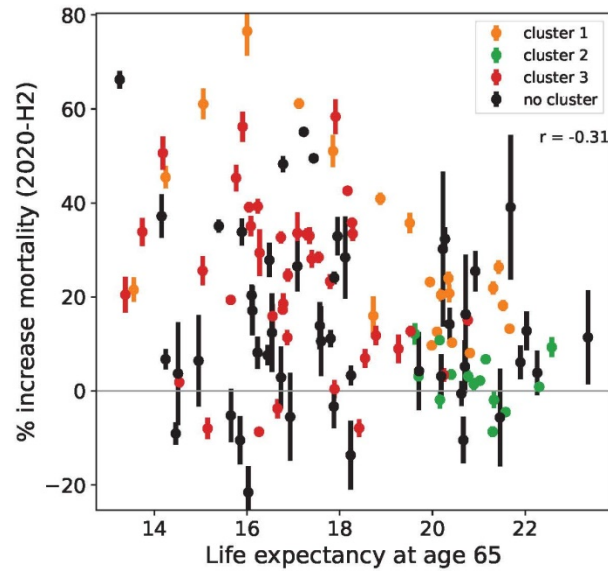
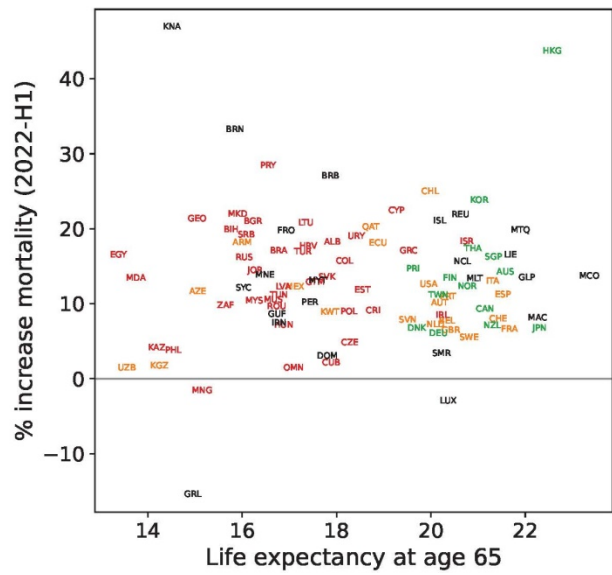
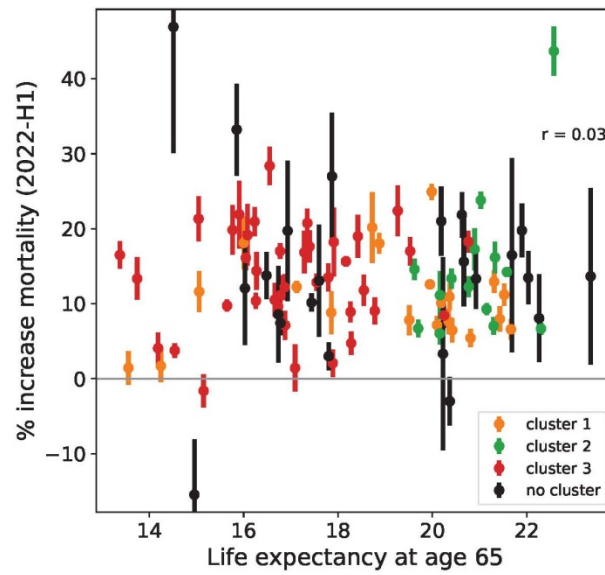
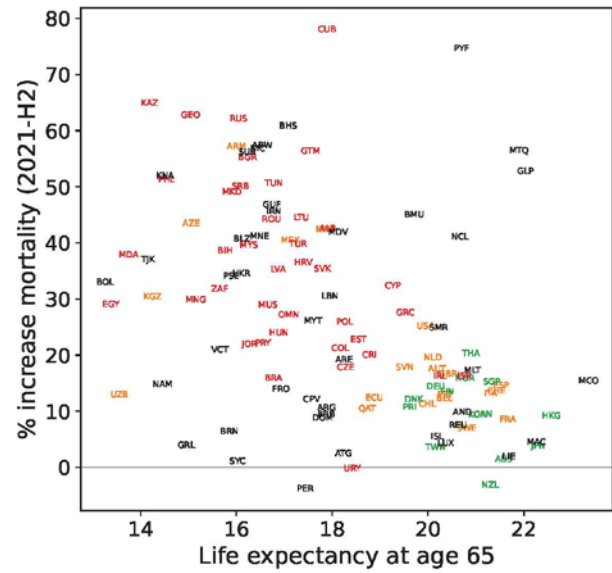
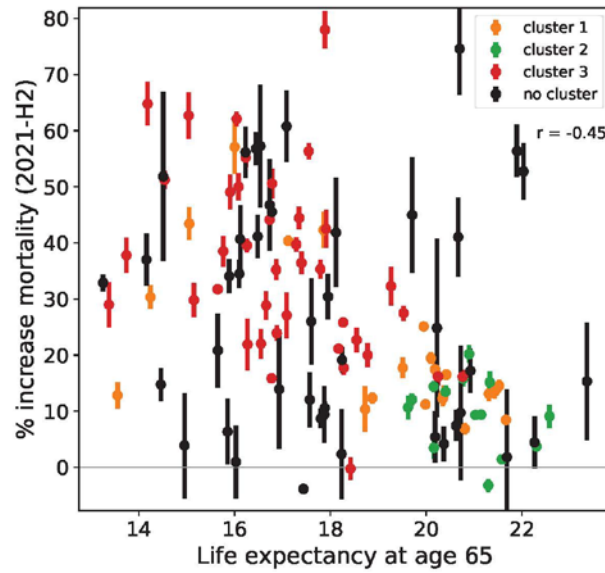


Figure 30. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period ("P-score"), versus median income per day, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







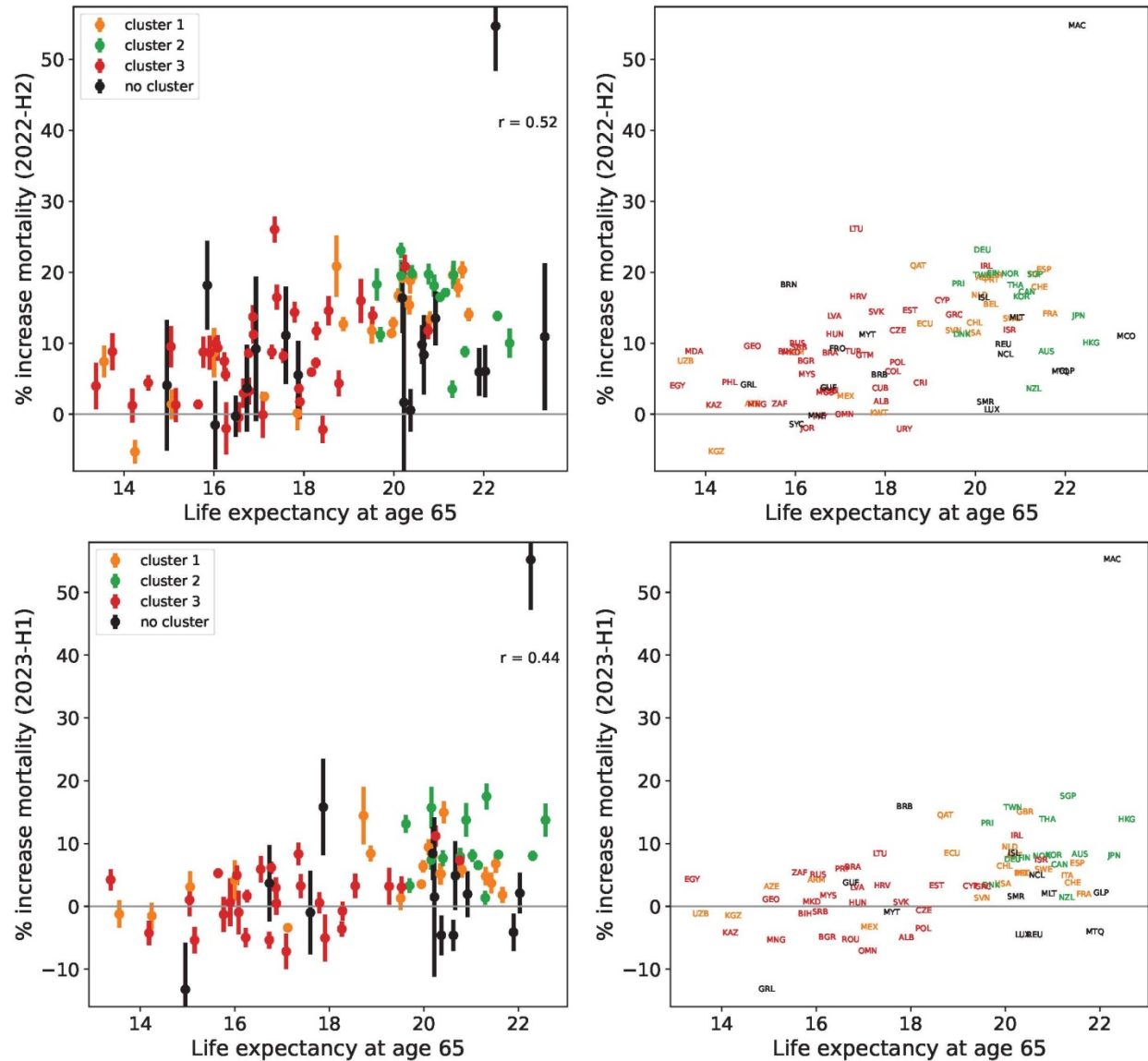
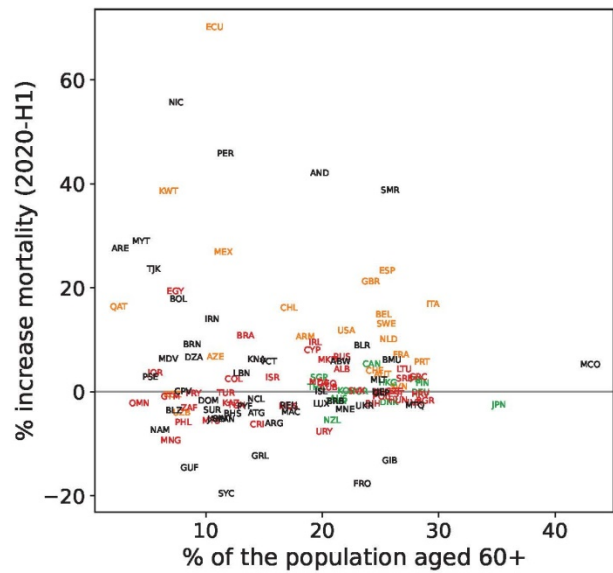
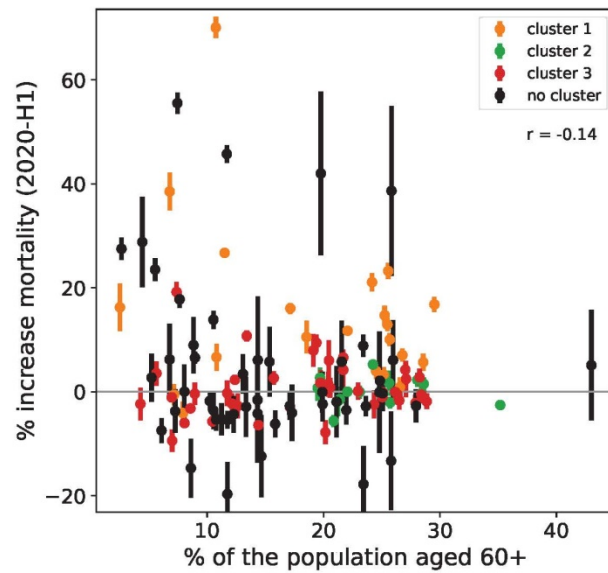
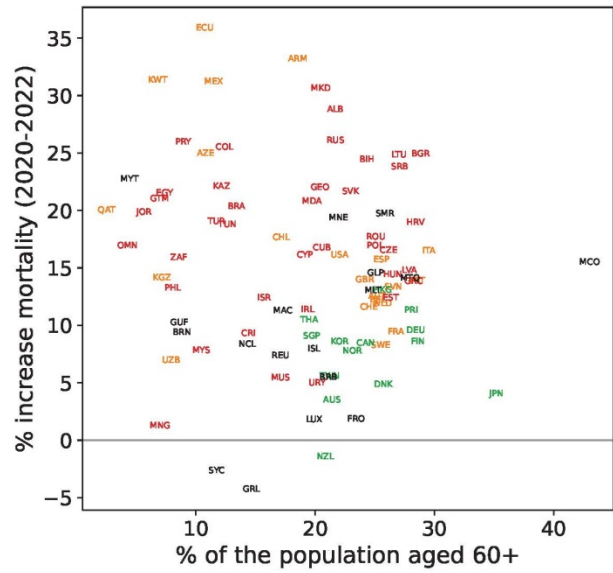
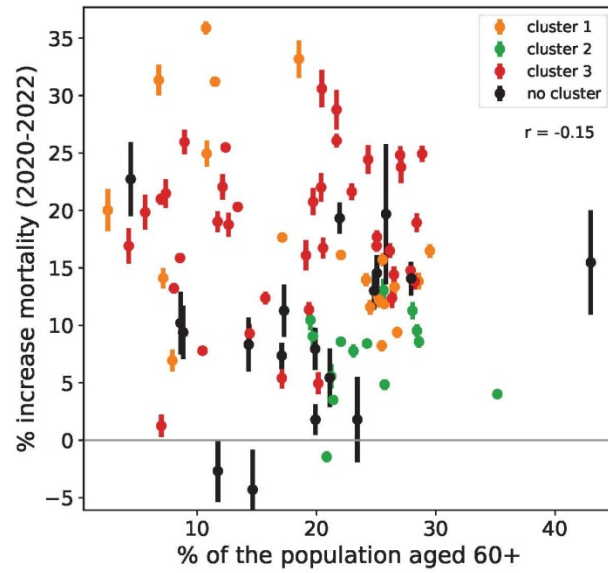
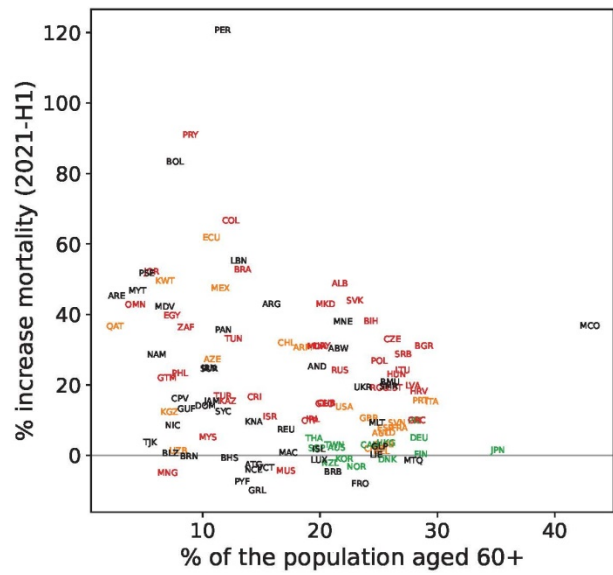
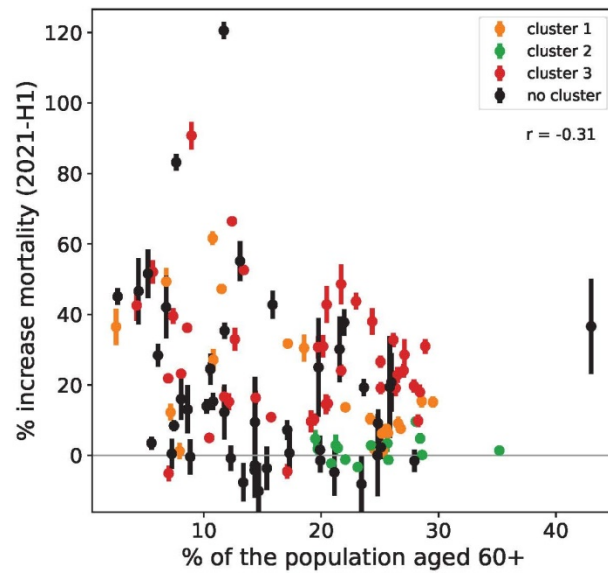
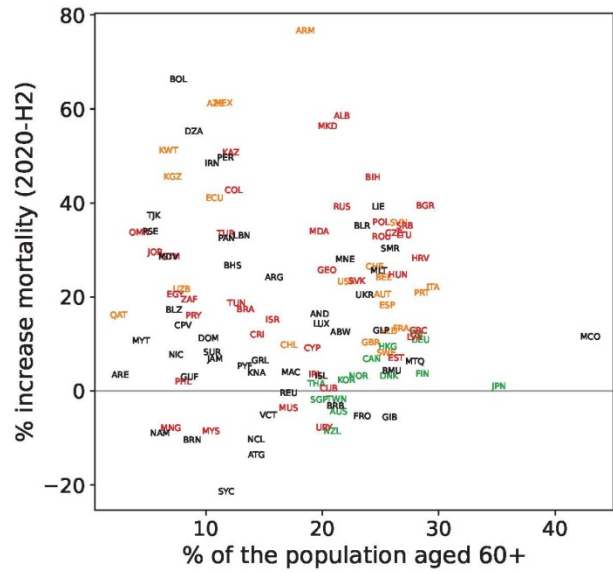
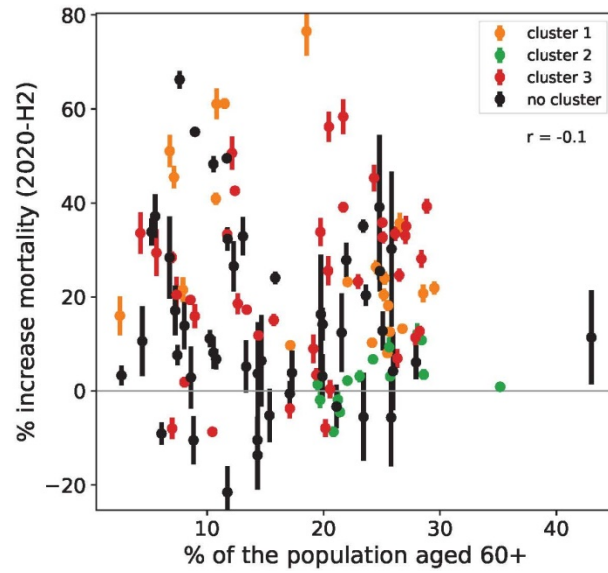
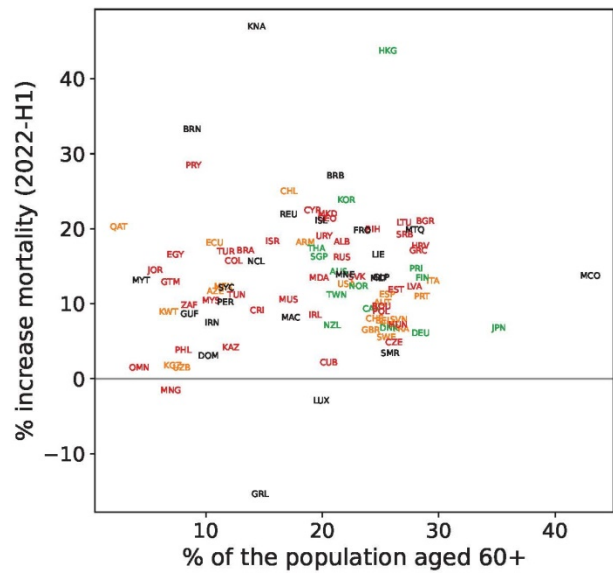
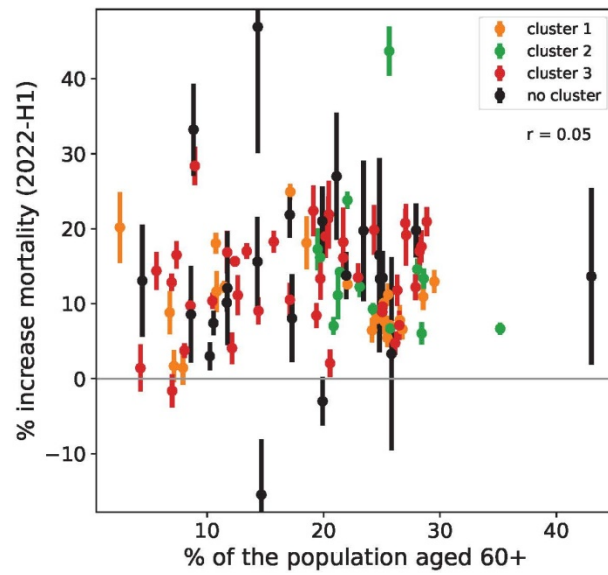
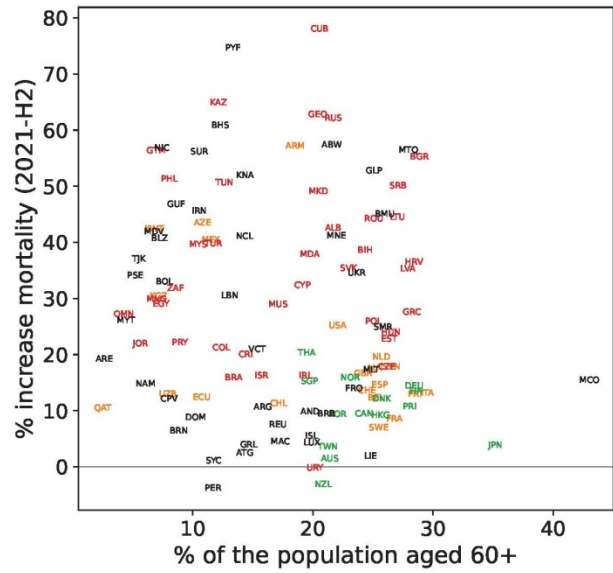
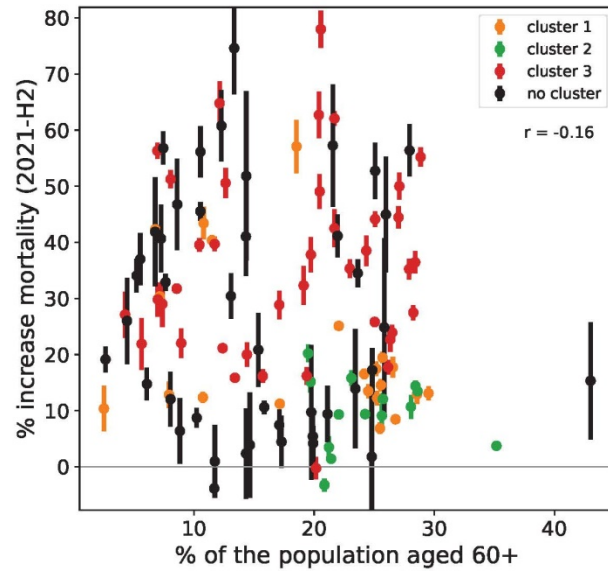


Figure 31. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus life expectancy at age 65, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







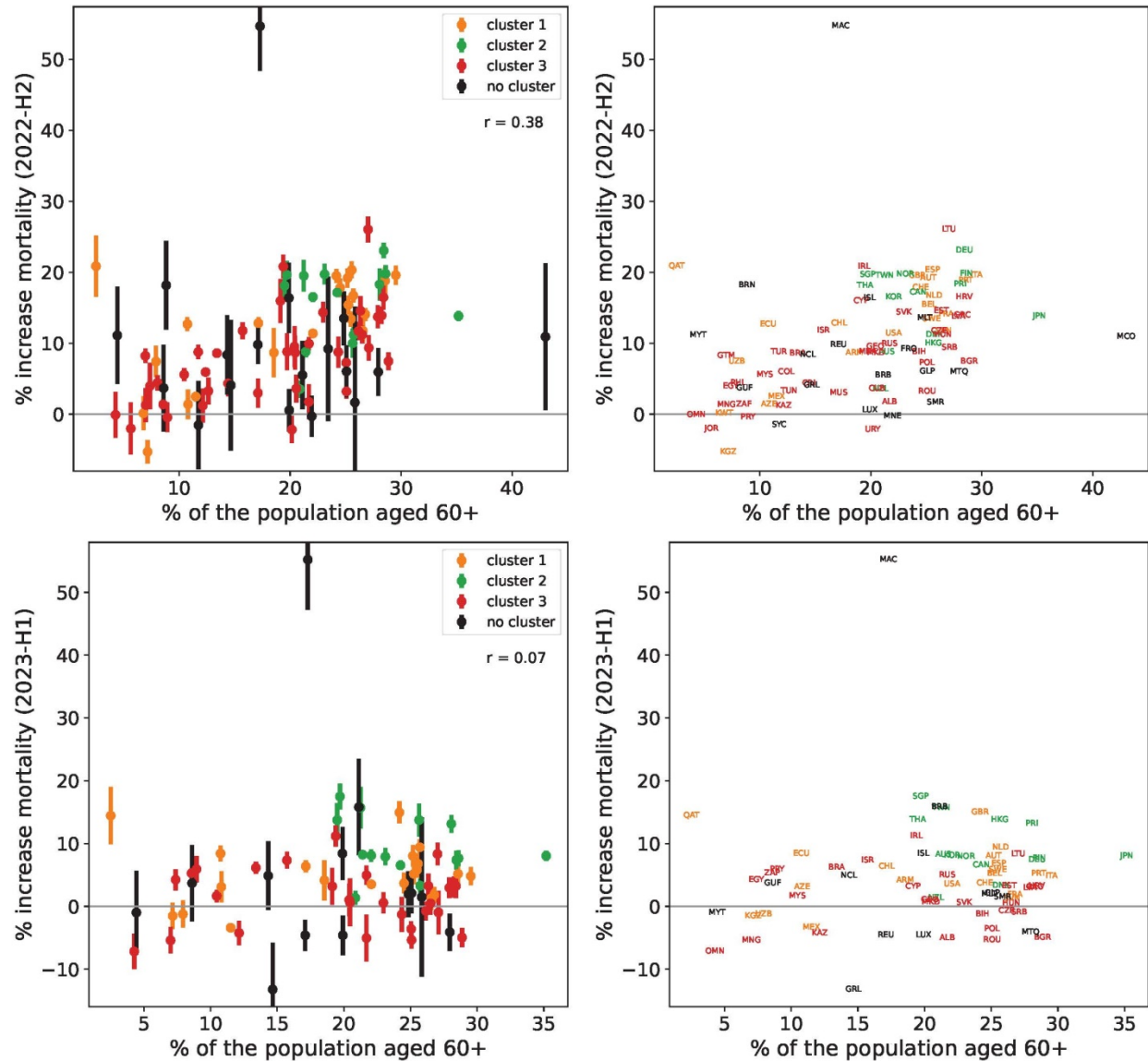
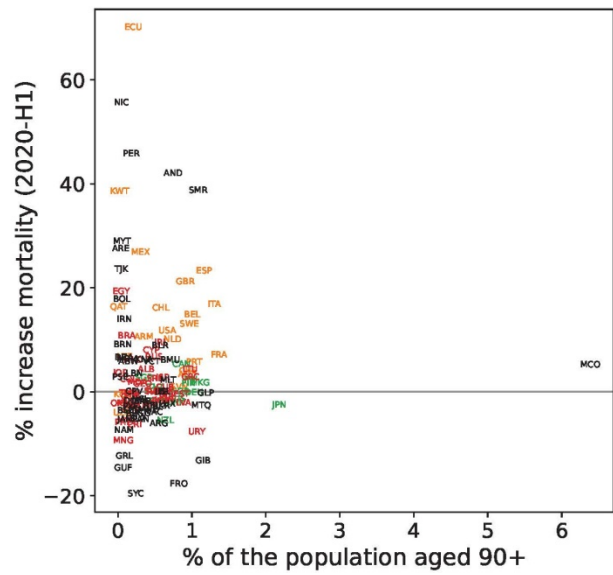
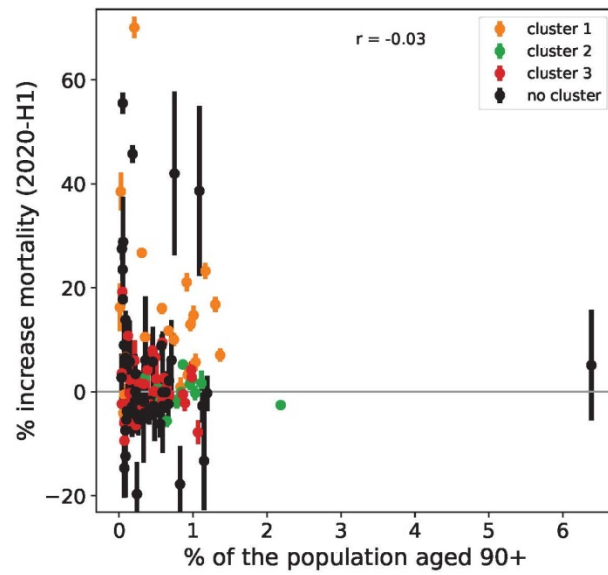
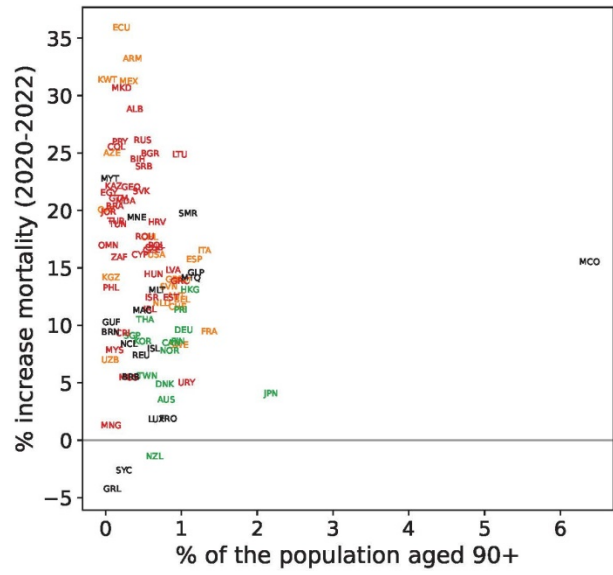
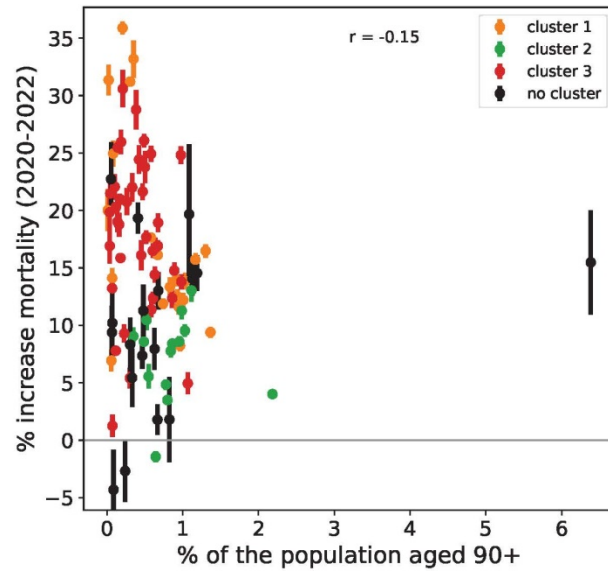
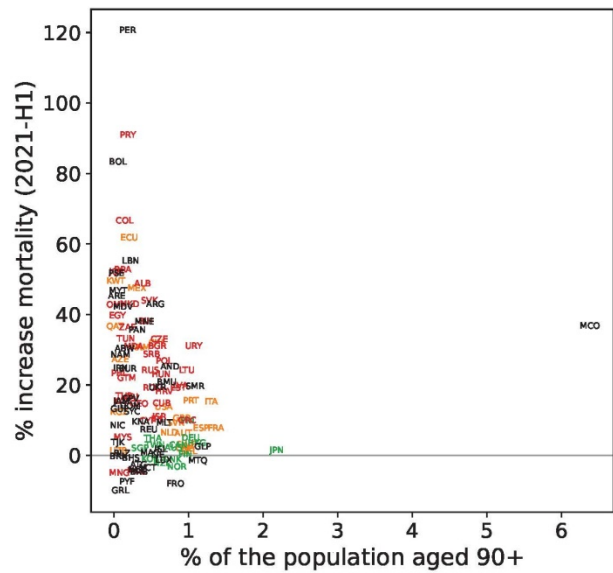
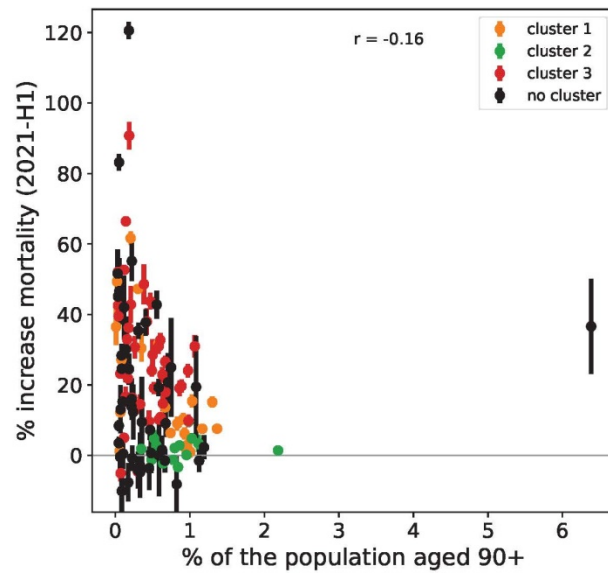
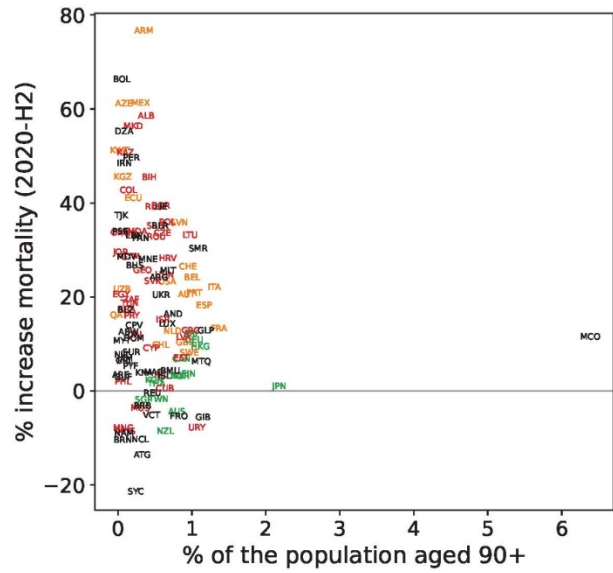
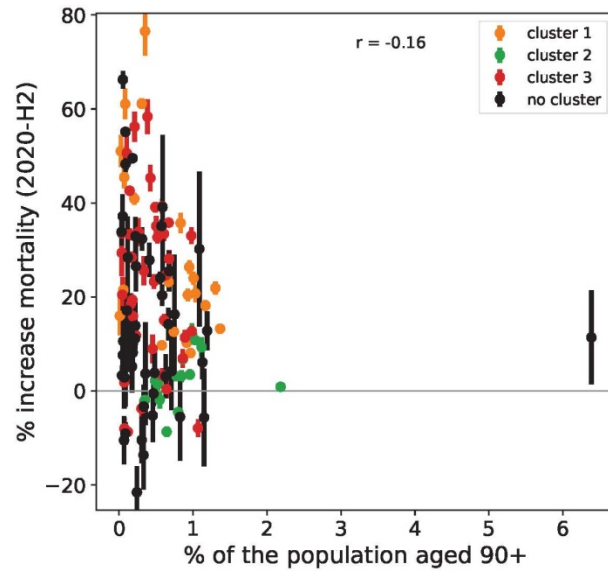
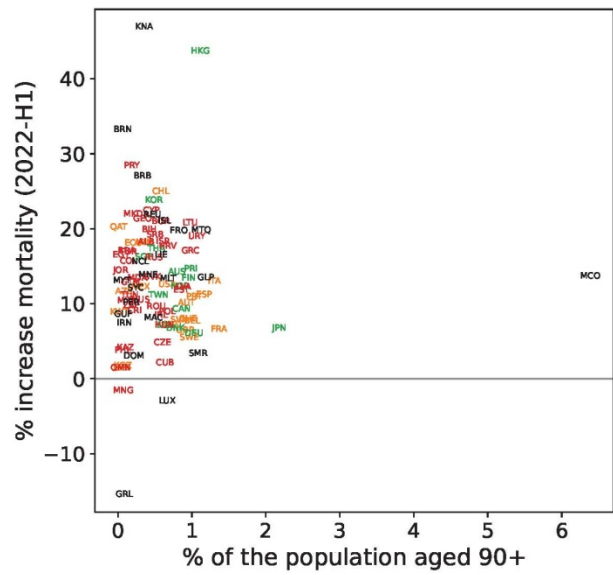
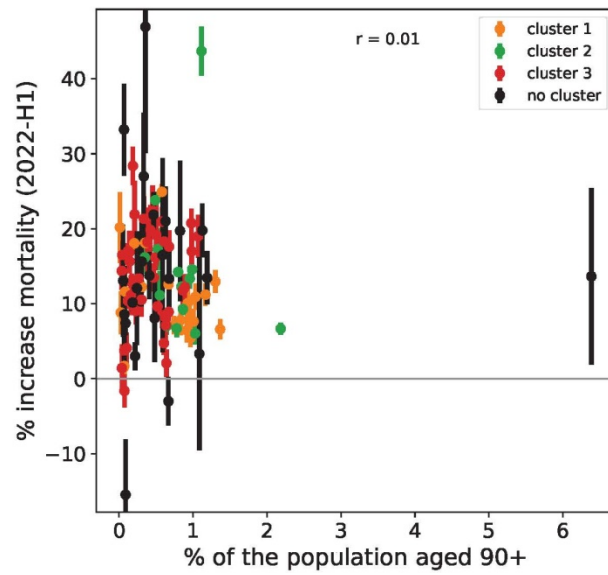
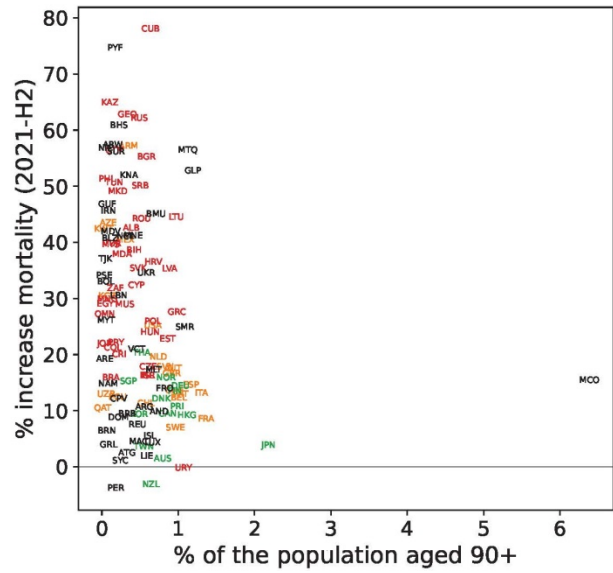
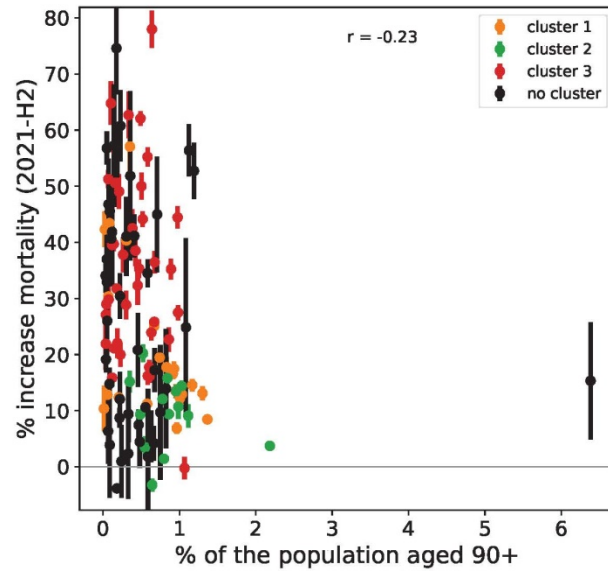


Figure 32. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus share of population aged 60+, with 1 σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







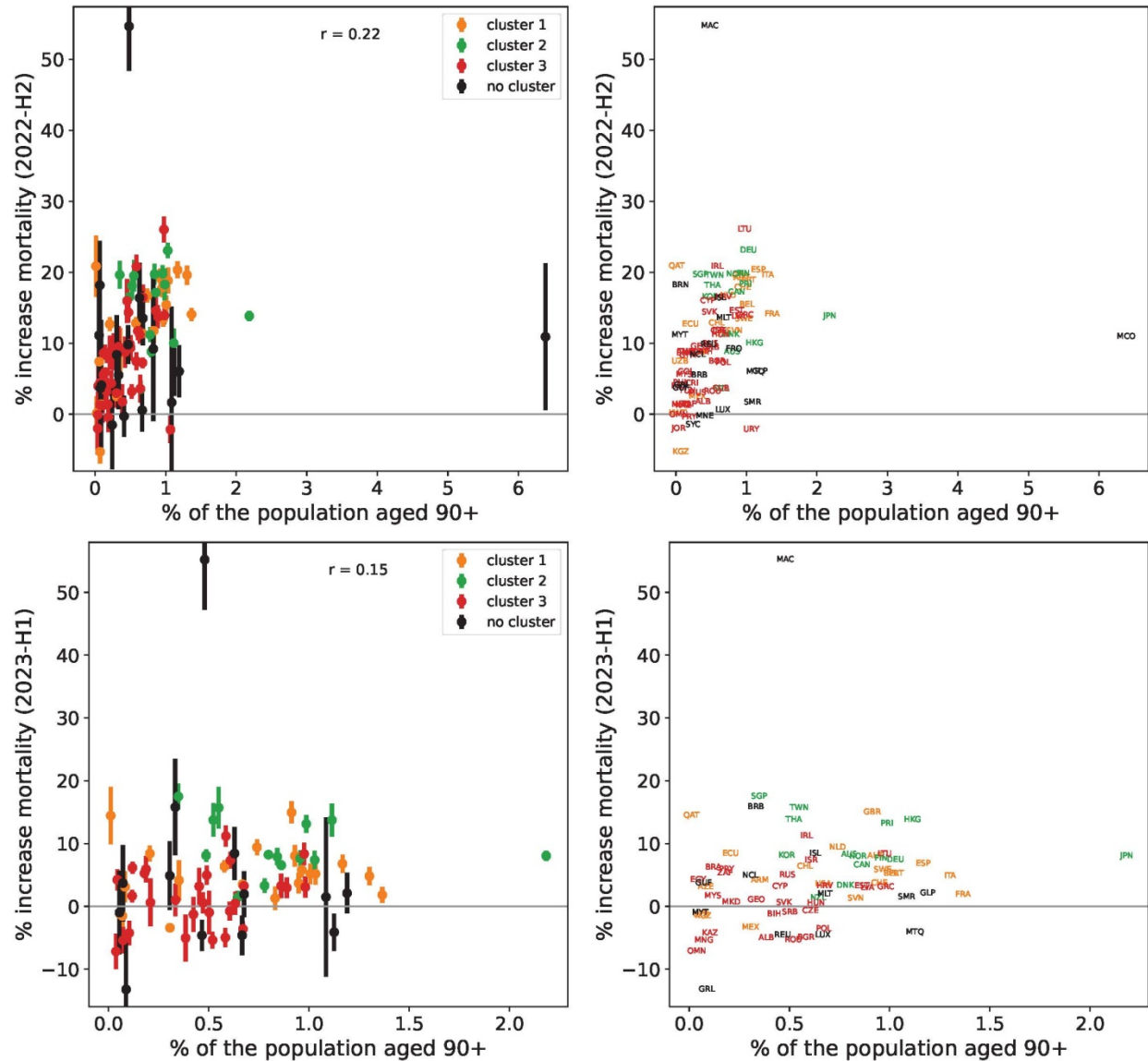


Figure 33. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus share of population aged 90+, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.

4.16 Excess all-cause mortality (as fraction of 2019 population) correlations with socio-economic variables

Raw excess mortality needs to be normalized in such a way as to allow valid country-to-country comparisons.

Each of the above figures (Figure 26 through Figure 33) is for excess all-cause mortality expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (equivalently, expressed as a “P-score”).

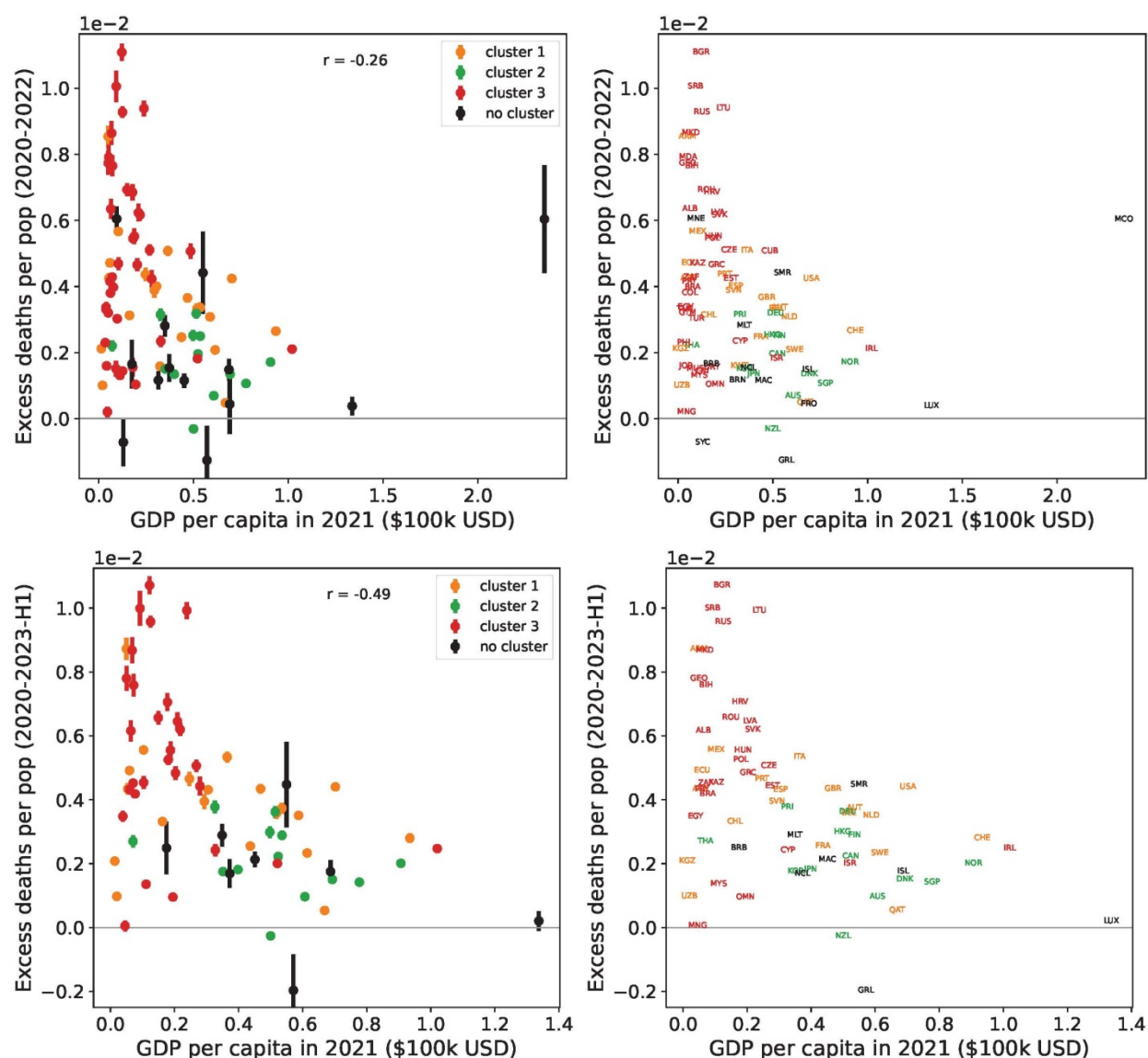
When excess mortality is expressed in this way (“P-score”), it is measured in comparison to the intrinsic baseline mortality rate (by time period) in the society or jurisdiction, and the latter includes all the factors affecting mortality, such as age structure and baseline health status.

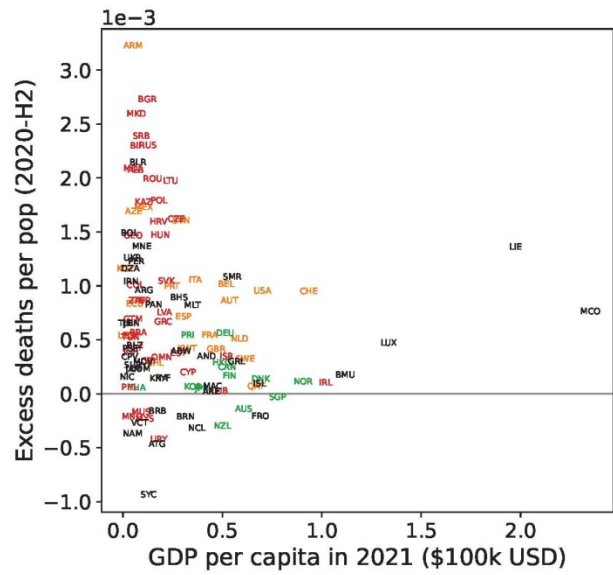
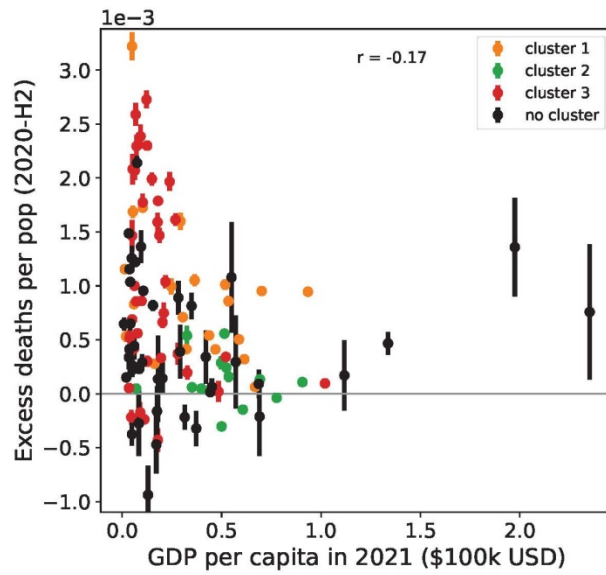
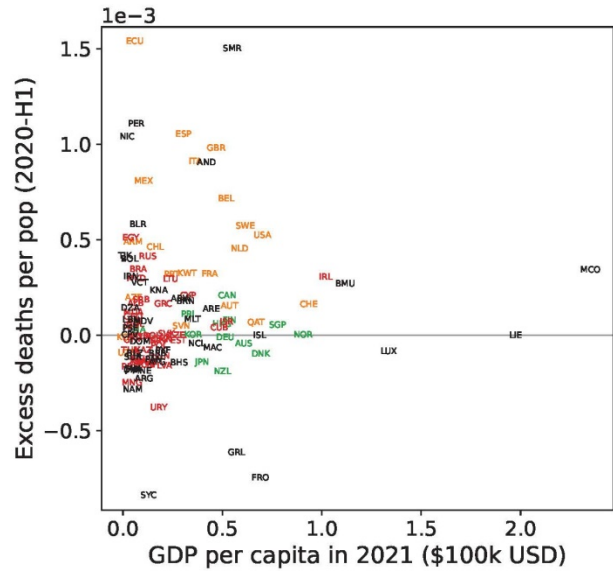
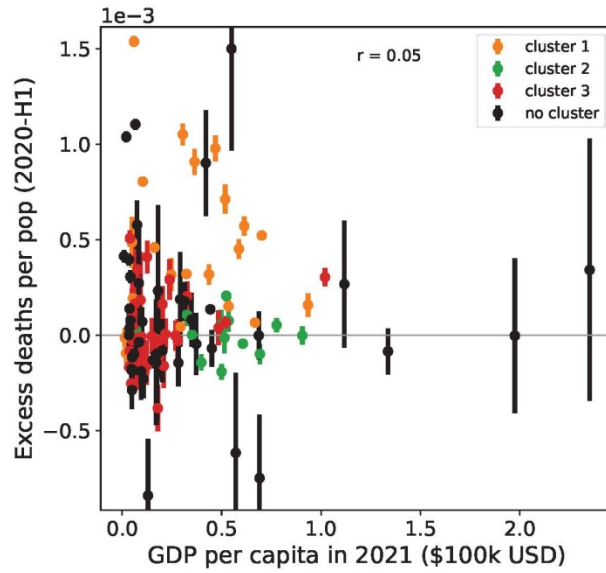
If we prefer to measure the excess mortality directly on a per population basis, irrespective of the health status and age structure of the population, then we express the excess all-cause mortality as a fraction of national population for a recent year. We use the year 2019.

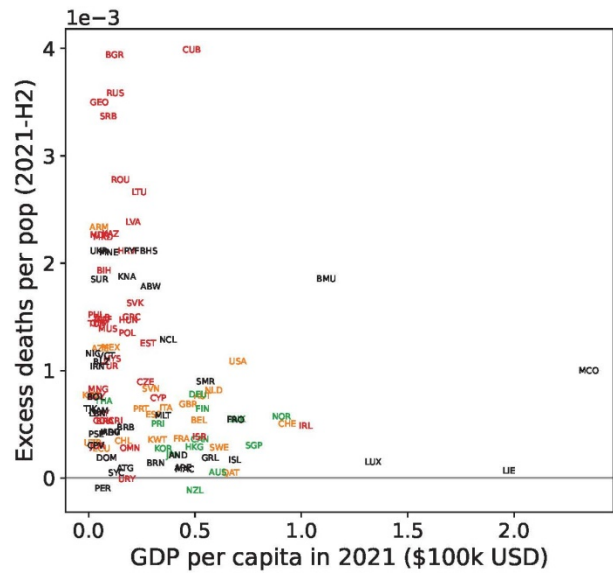
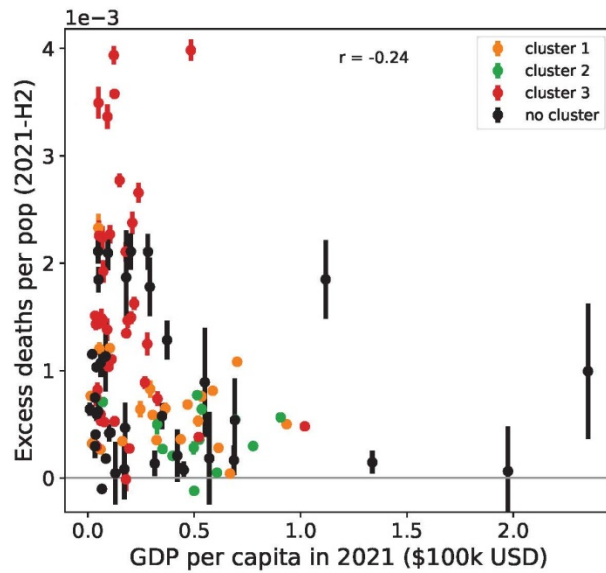
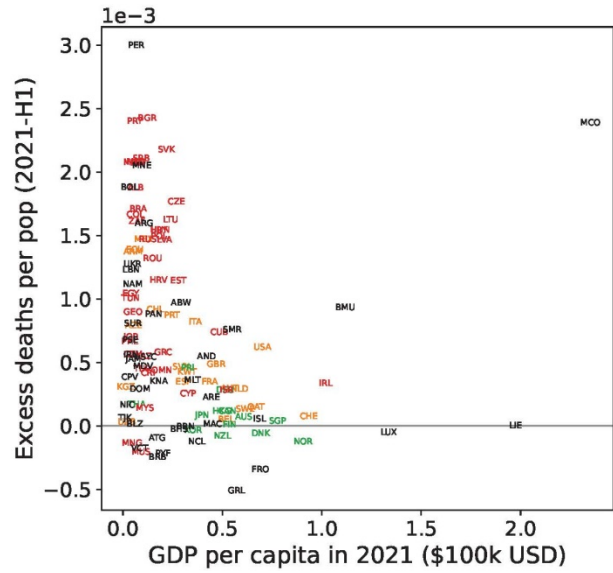
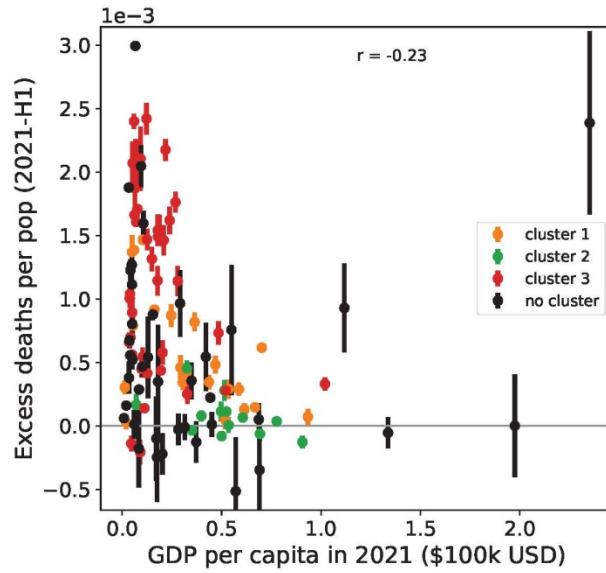
The two excess-mortality normalizations (“P-score” or by population) produce different numbers, having their distinct meanings, and in general produce different correlations and correlation coefficients for a given socio-economic variable.

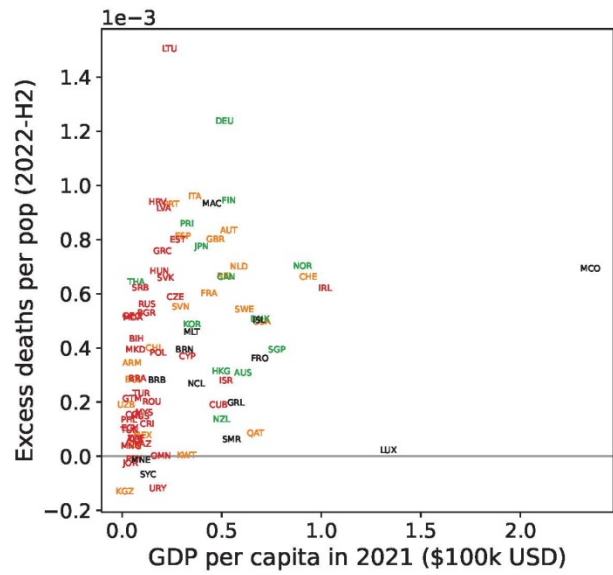
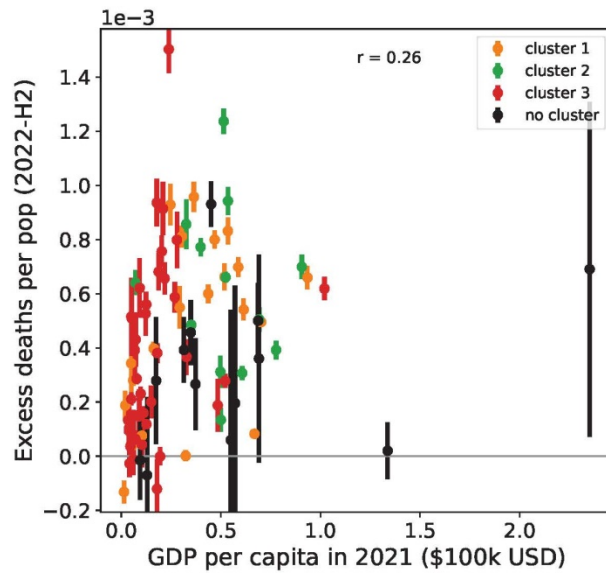
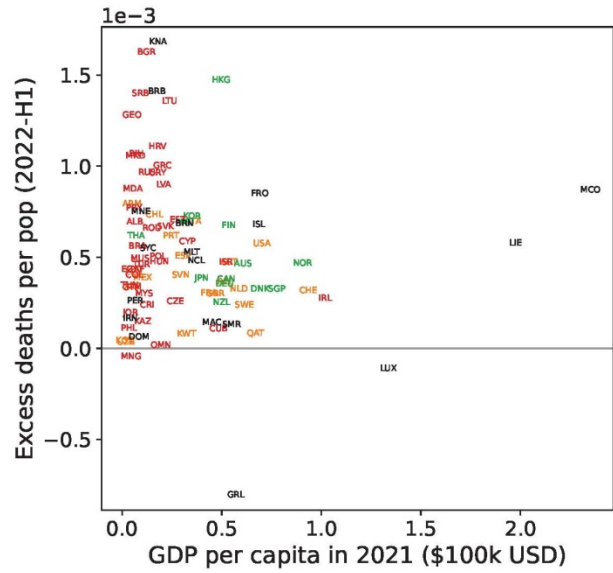
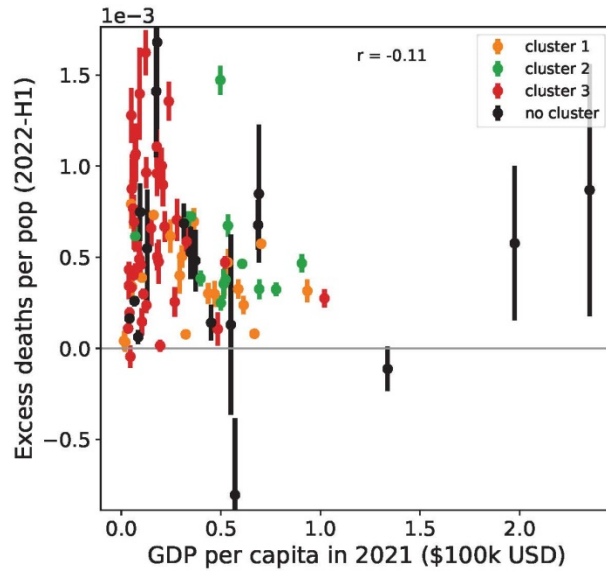
The correlations between excess all-cause mortality expressed on a per population basis during the Covid period and socio-economic variables are shown in the figures below (Figure 34 through Figure 41), for GDP per capita, Gini inequality index, share of population living on less than \$5.50 per day, share of population living on less than \$30 per day, median income per day, life expectancy at age 65, share of population aged 60+, and share of population aged 90+. In each case, the thus normalized excess all-cause mortality is for the Covid period itself (2020-2022 and 2020-2023-H1) and for

each half year in the Covid period, 2020-H1 to 2023-H1. Here, the nominal Covid periods 2020-2022 and 2020-2023-H1 include different numbers of points (countries), as do different half years (as above), depending on availability of mortality data for each half year. **Appendix H** lists all the corresponding extracted Pearson correlation coefficients.









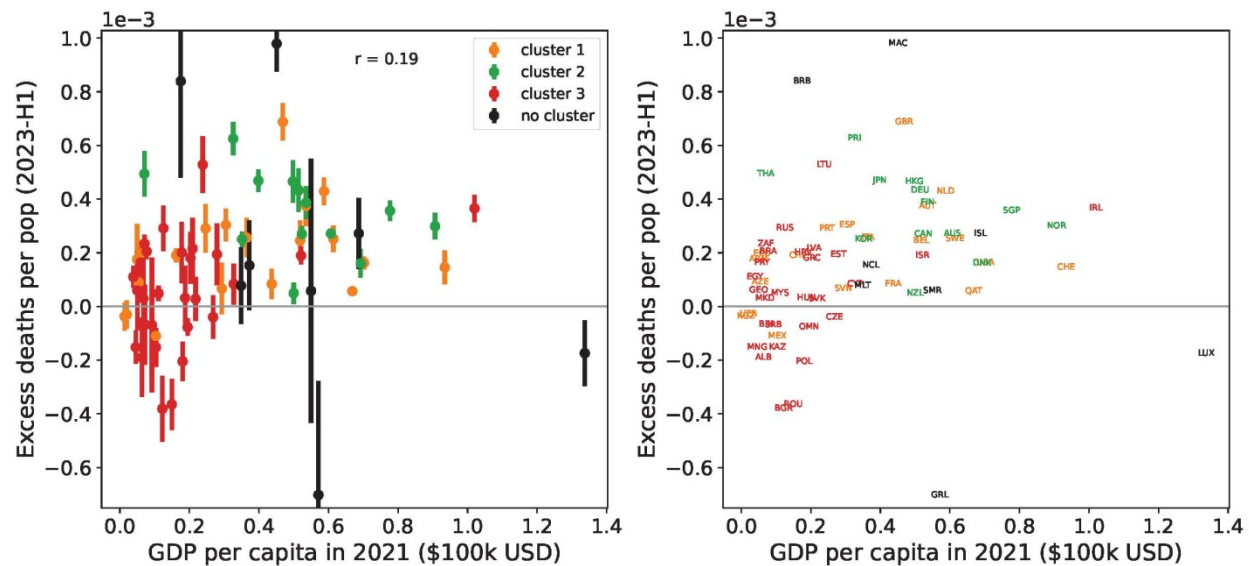
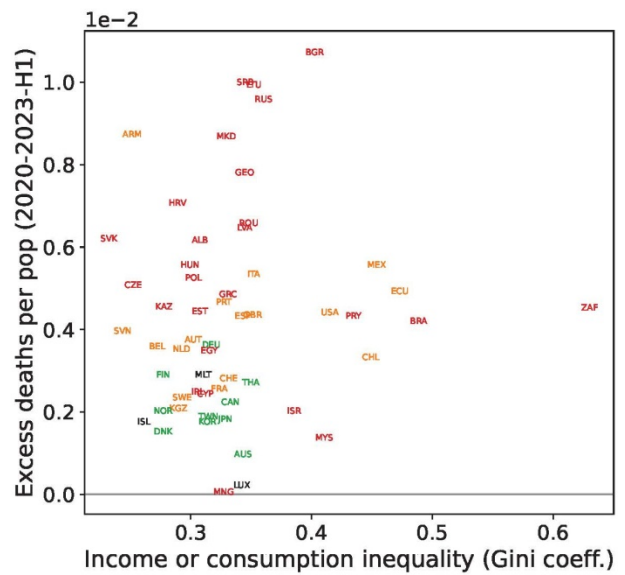
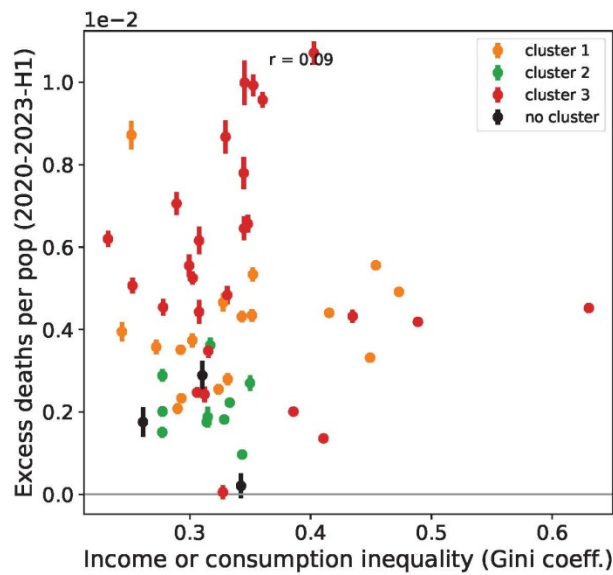
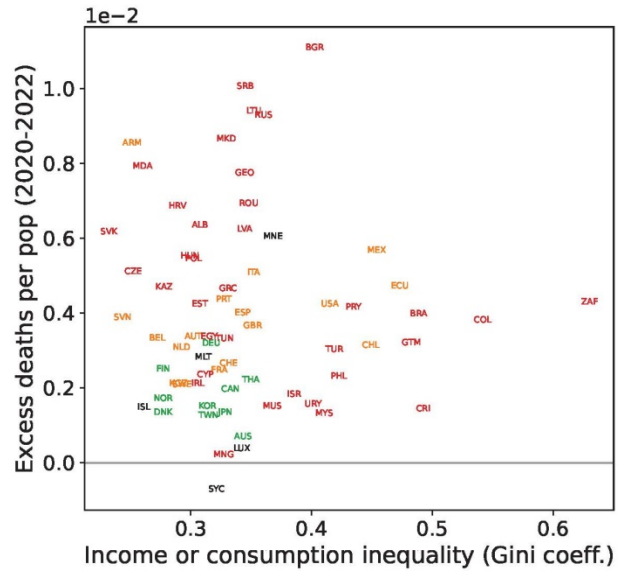
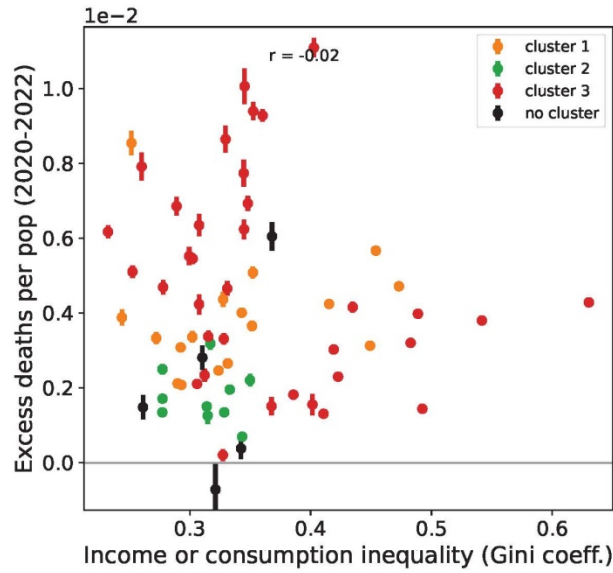
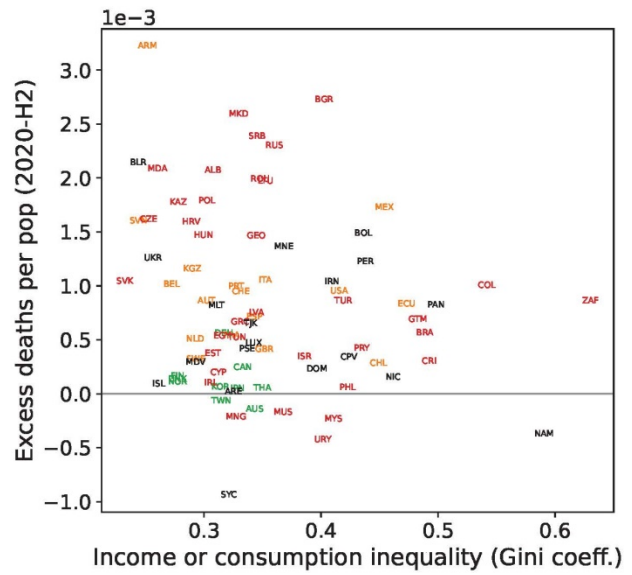
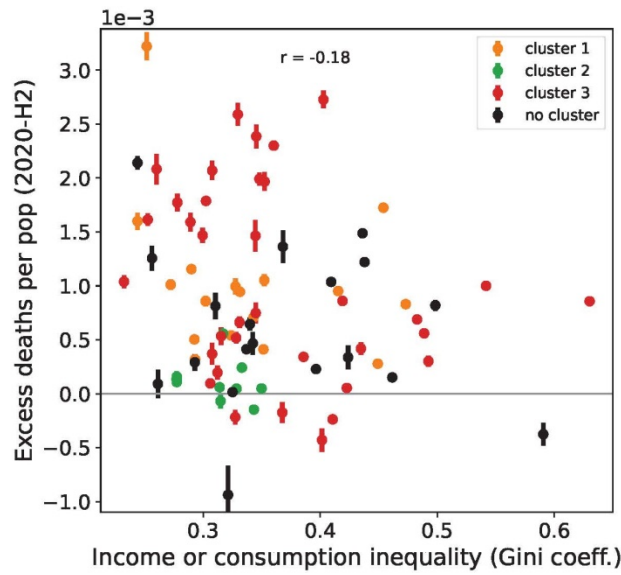
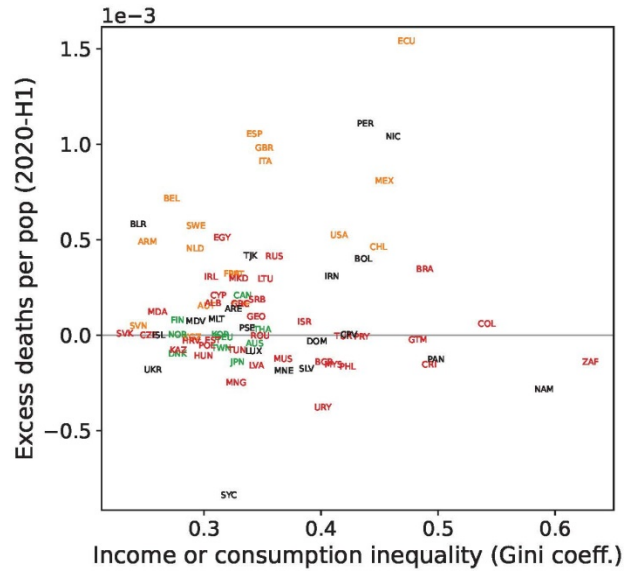
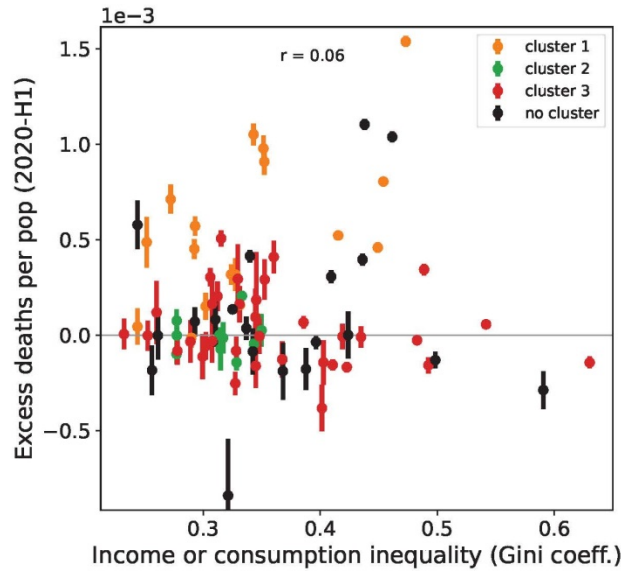
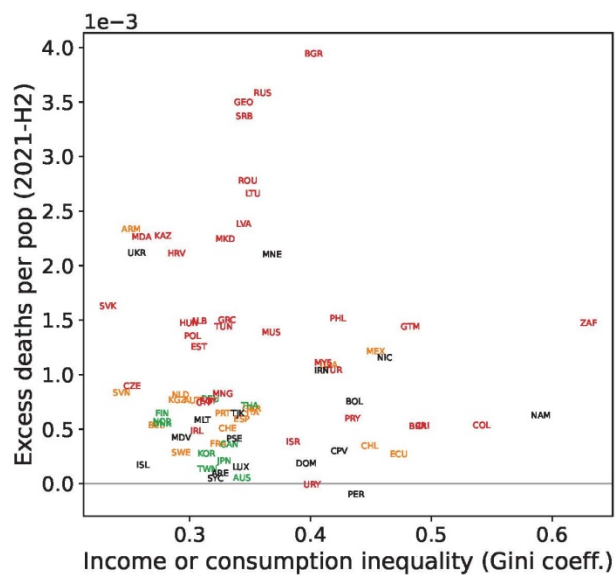
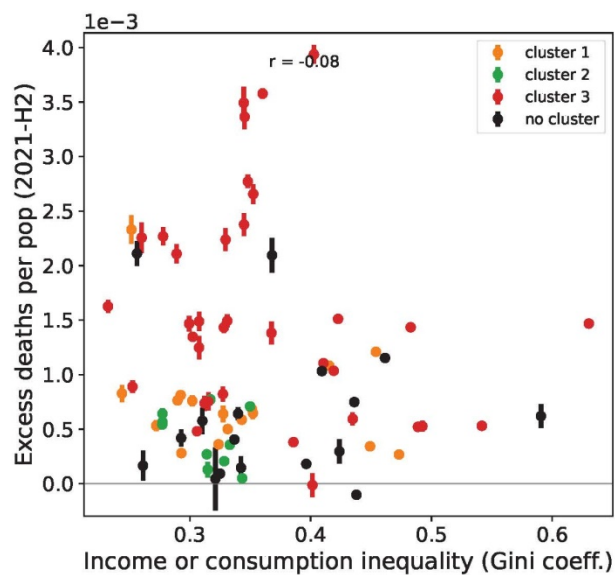
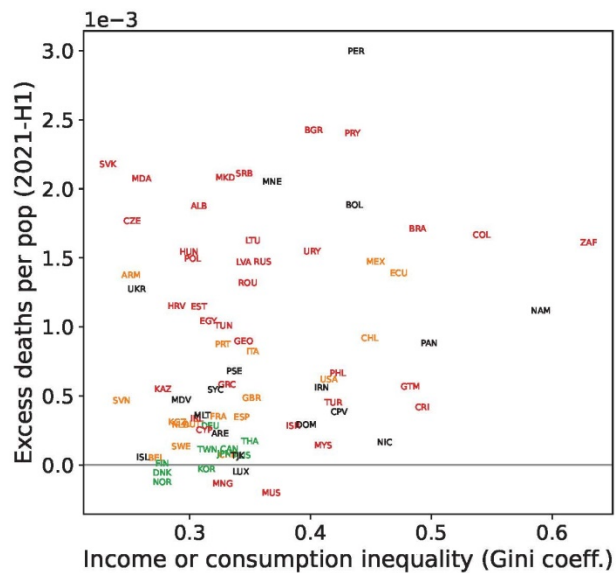
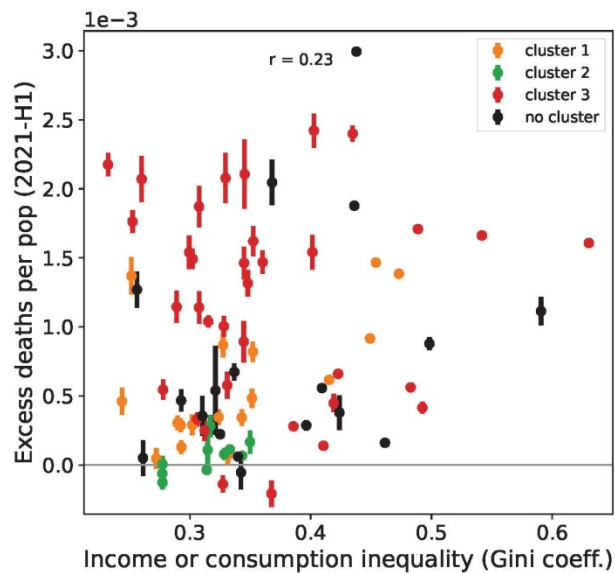
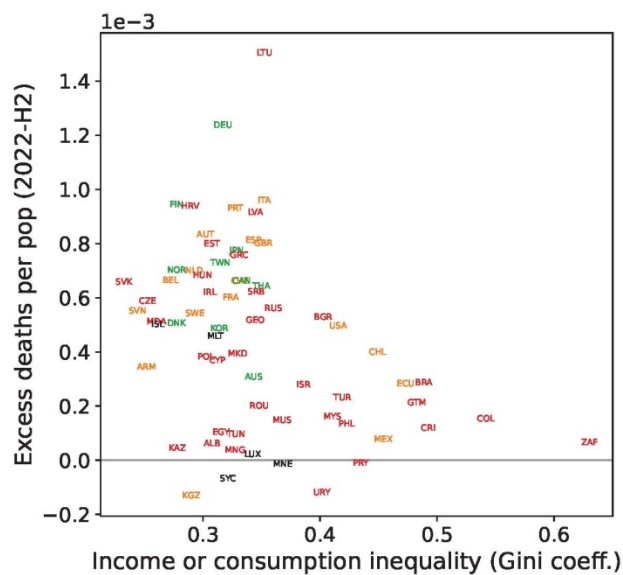
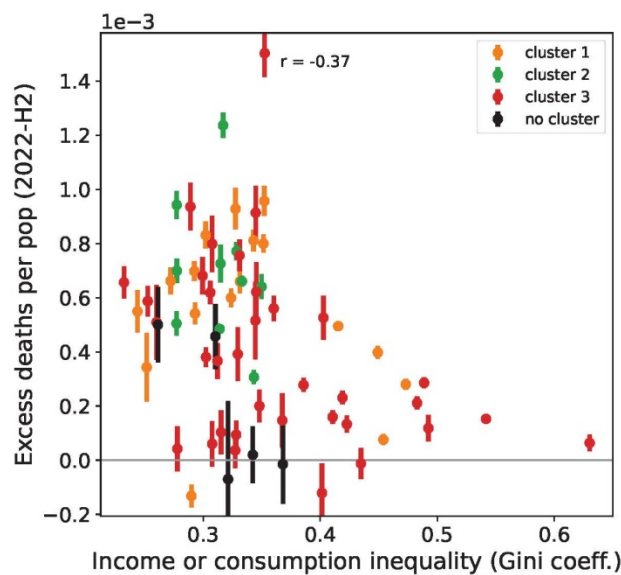
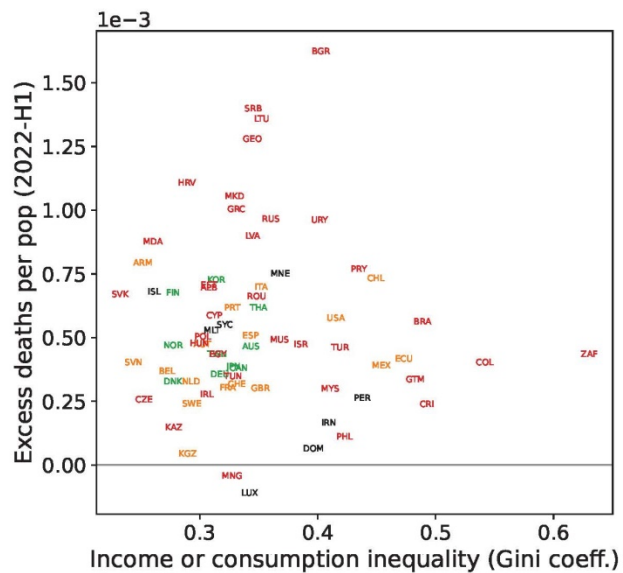
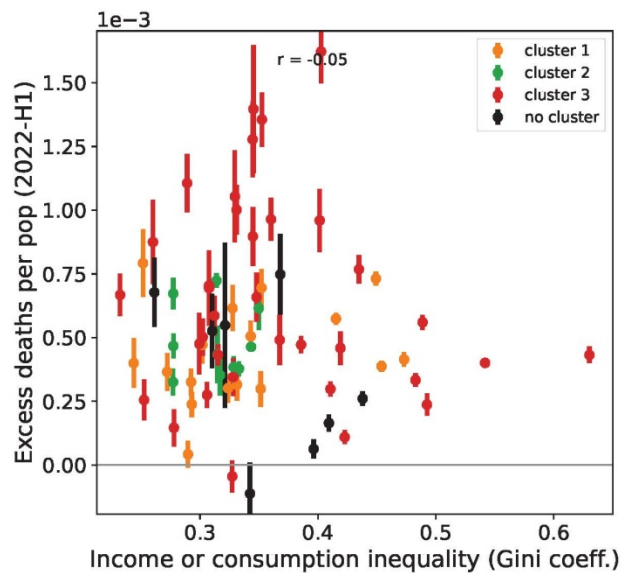


Figure 34. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus GDP per capita, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.









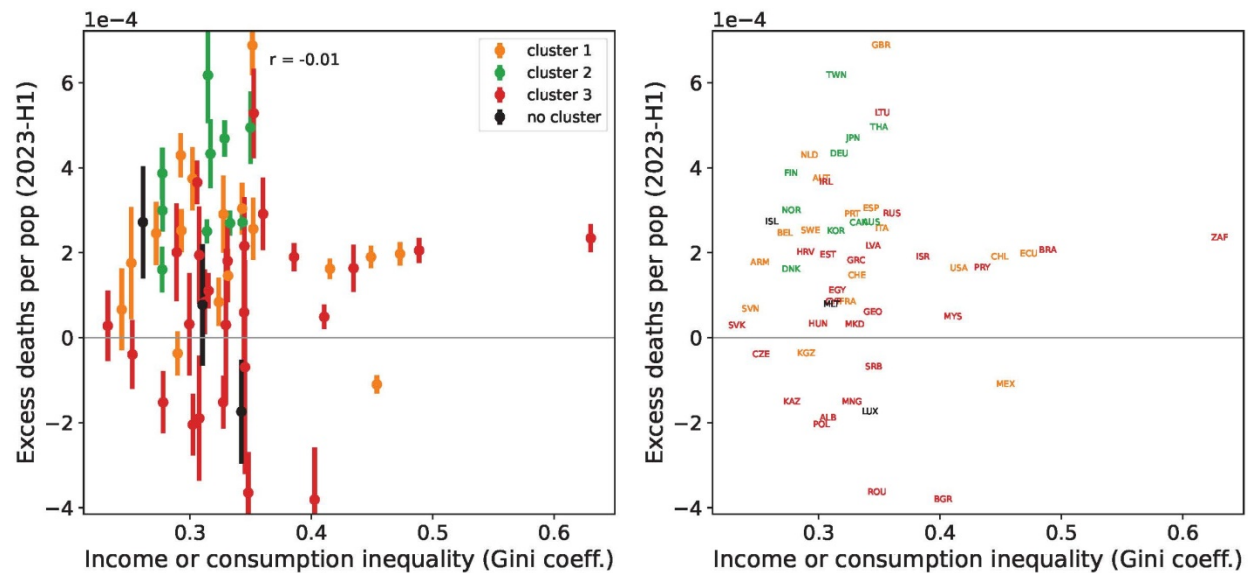
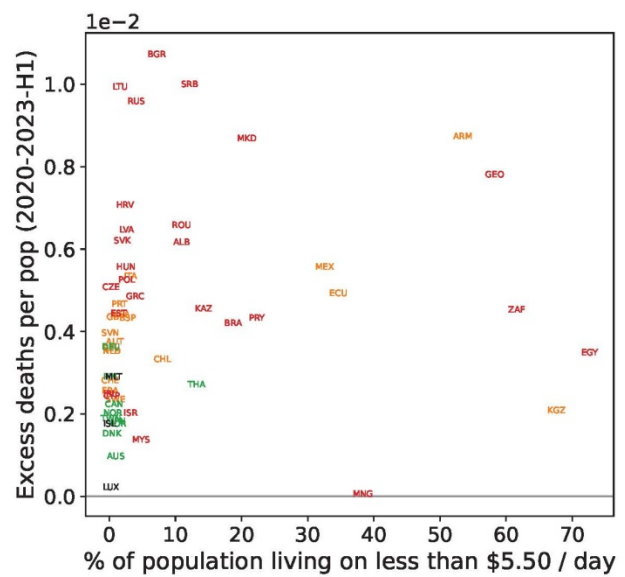
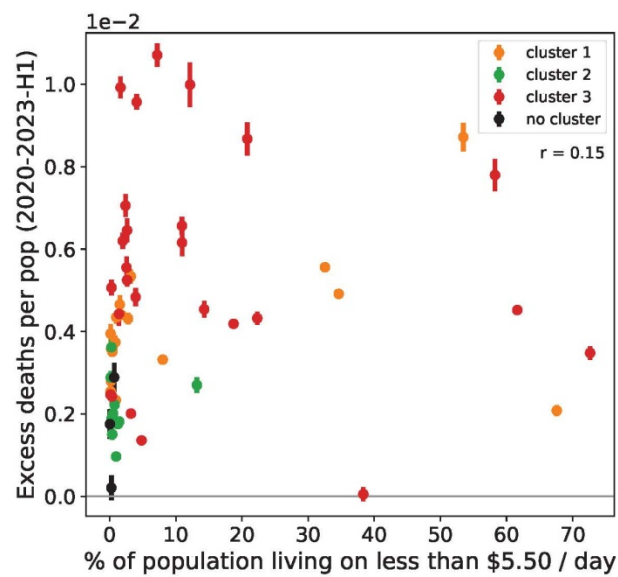
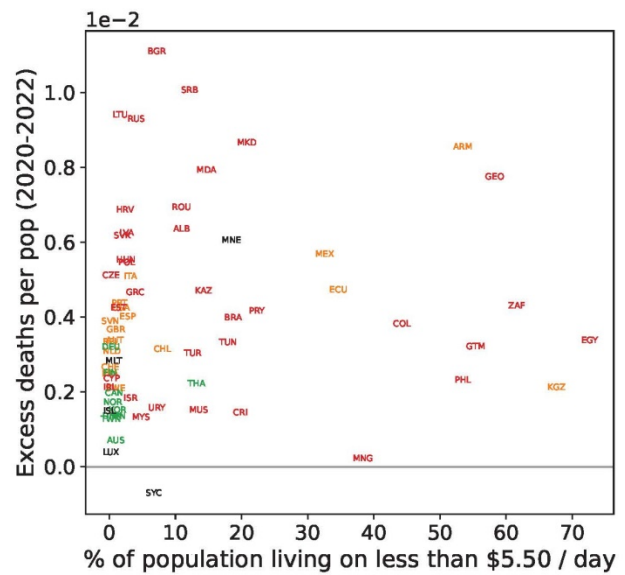
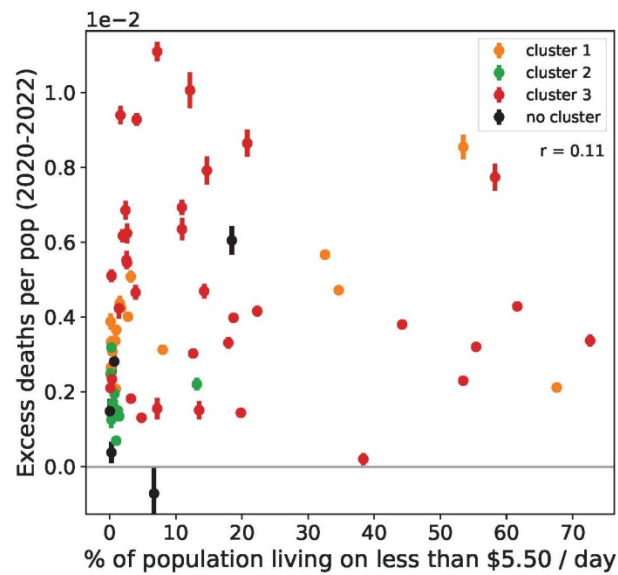
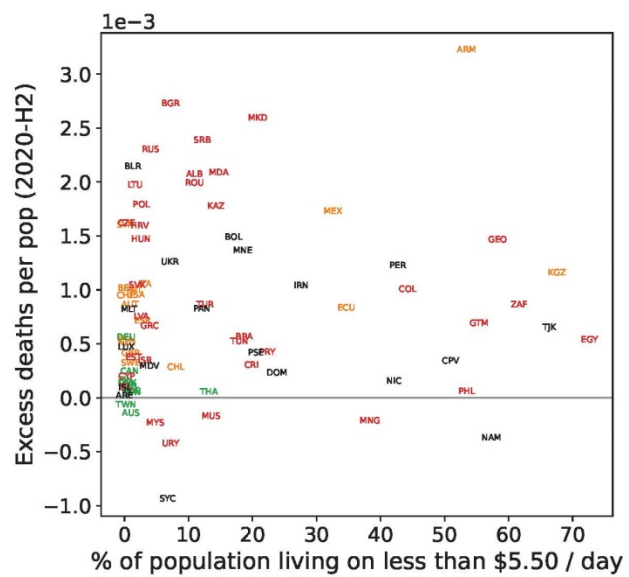
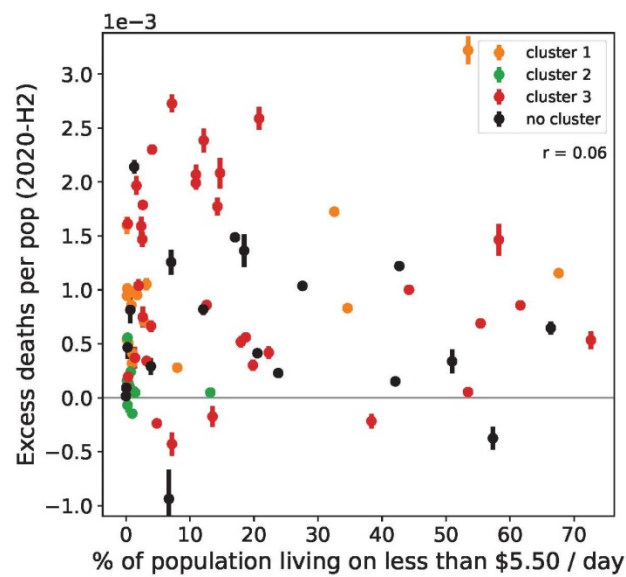
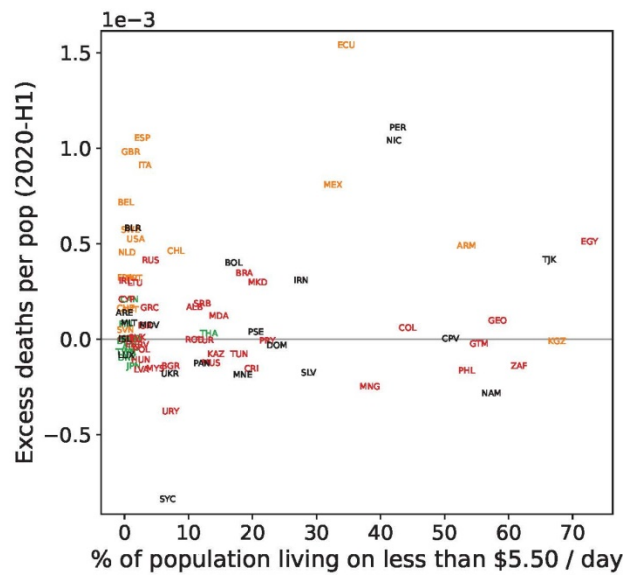
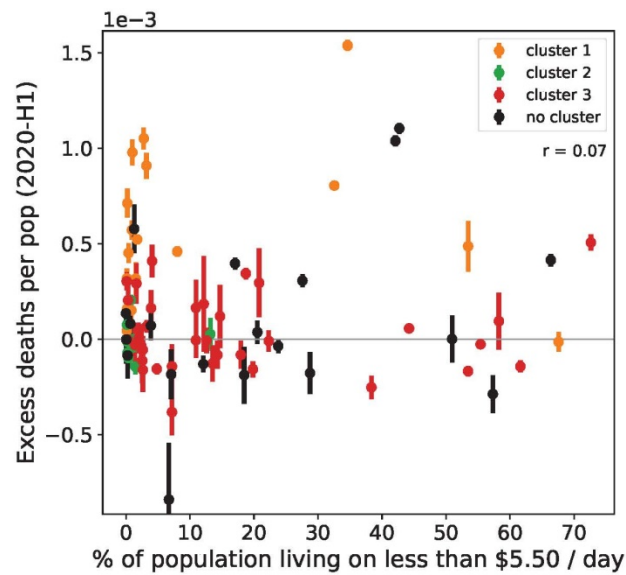
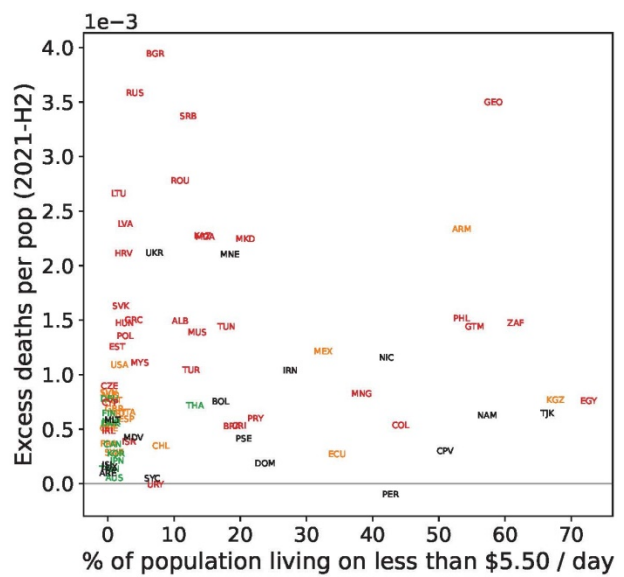
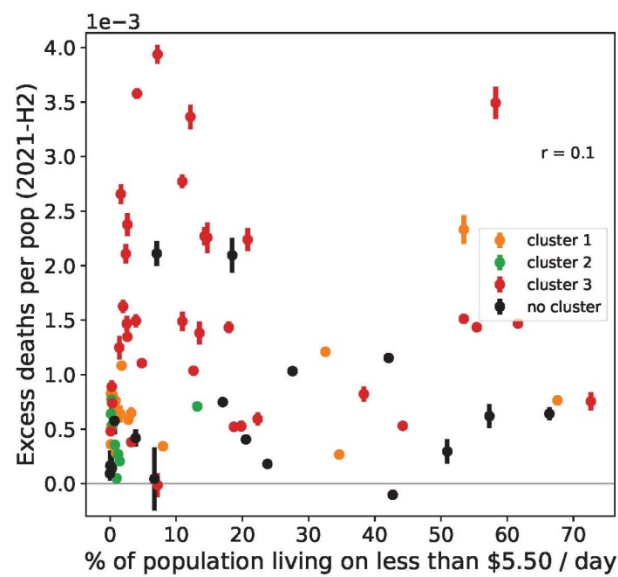
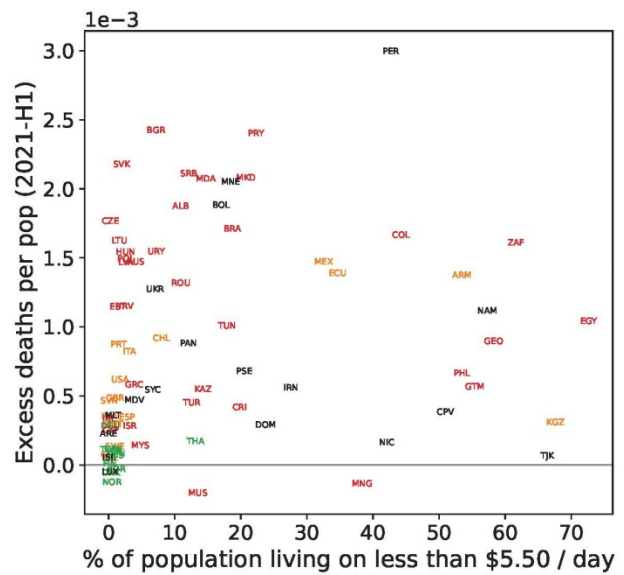
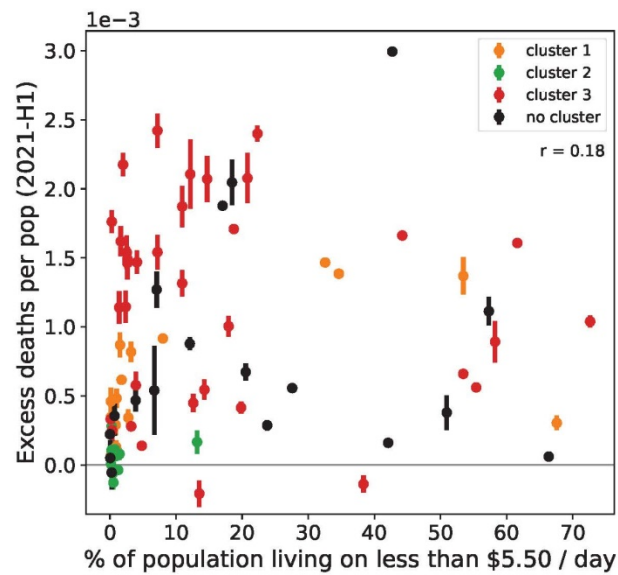
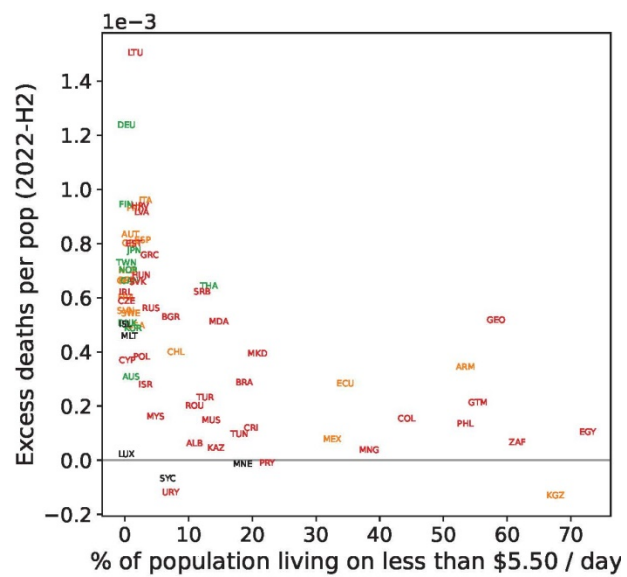
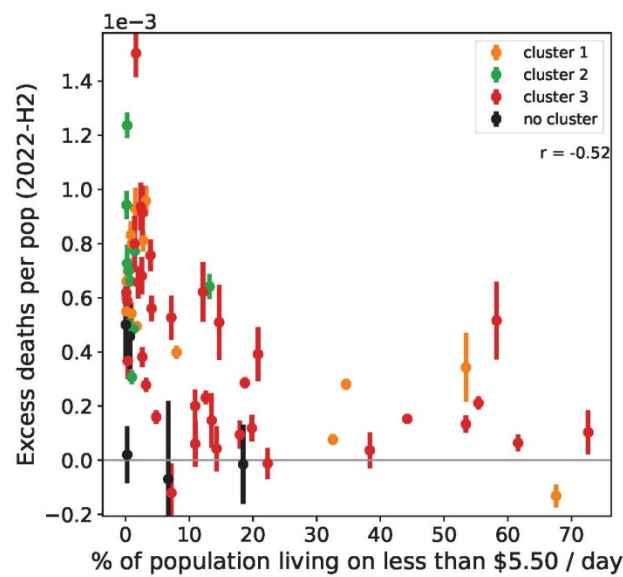
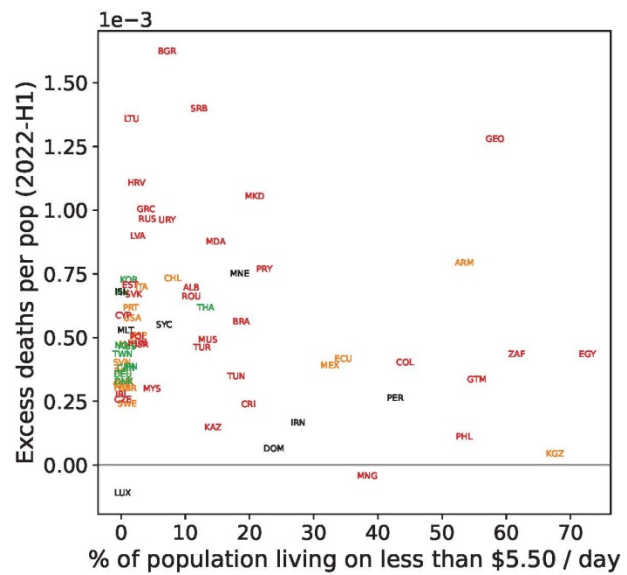
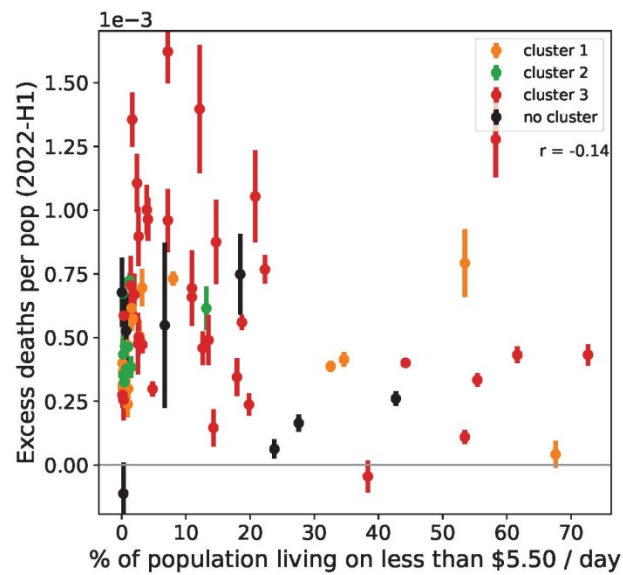


Figure 35. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus Gini inequality index, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.









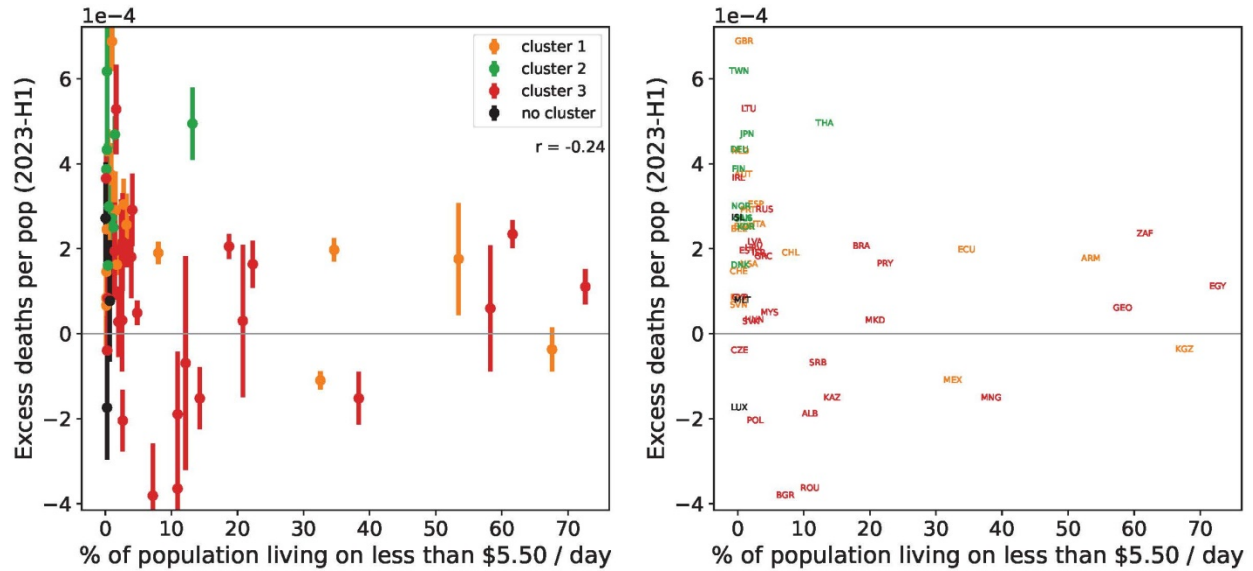
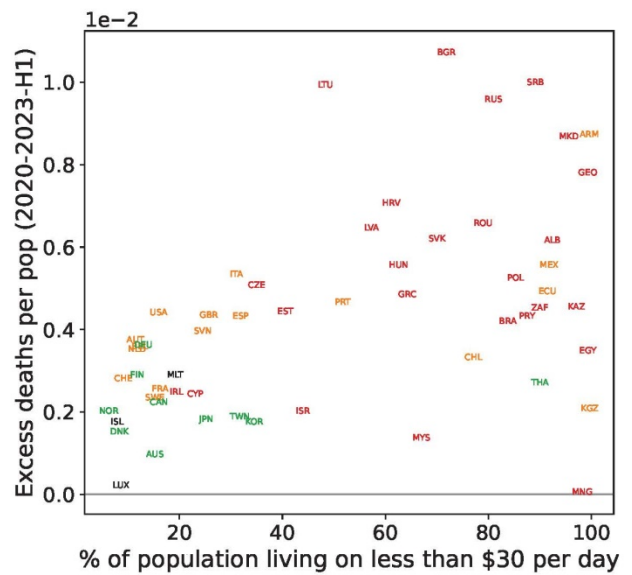
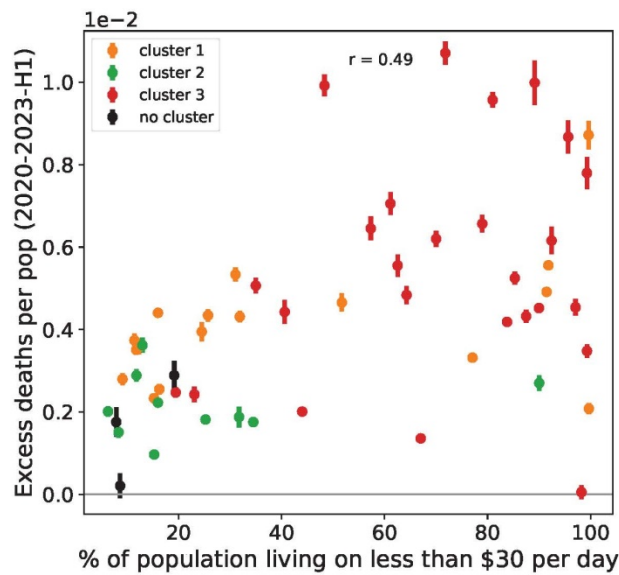
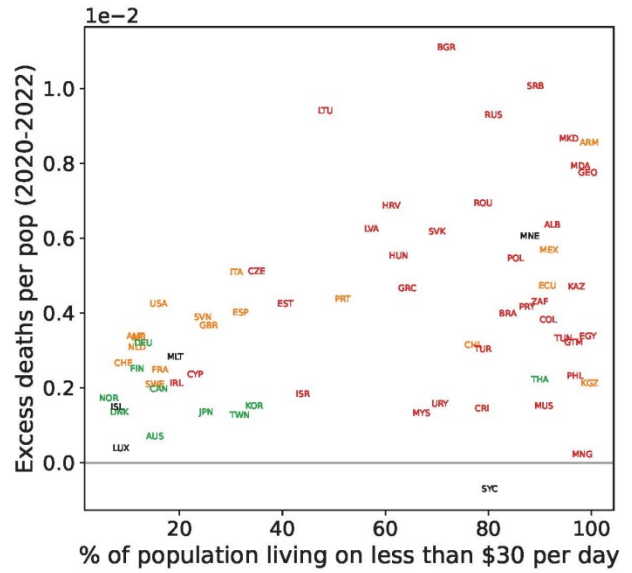
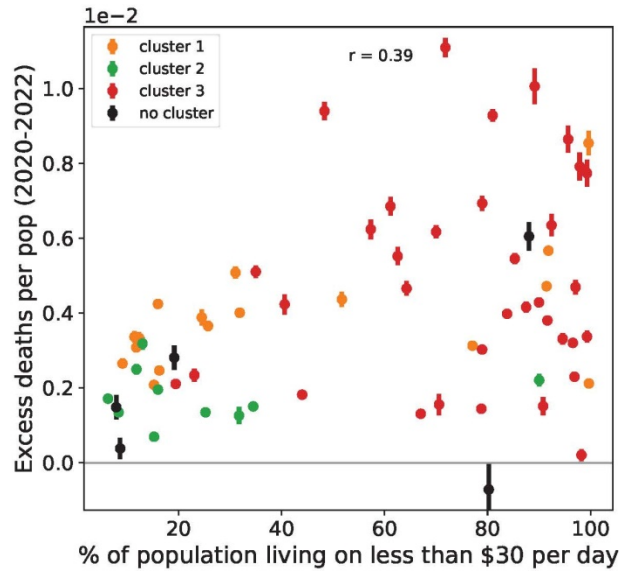
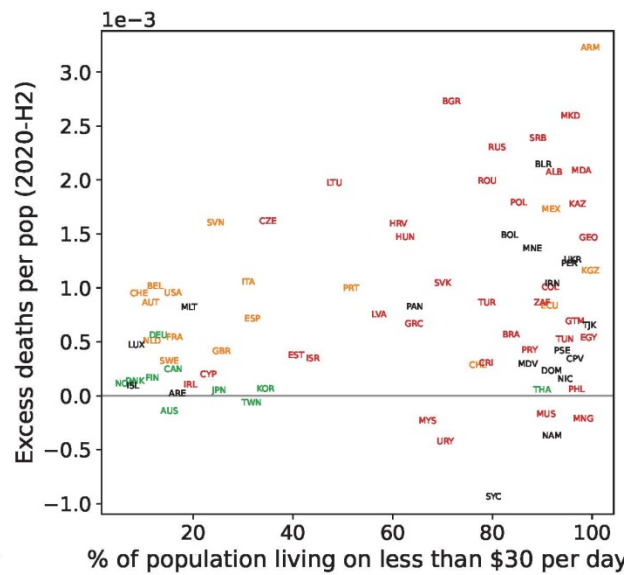
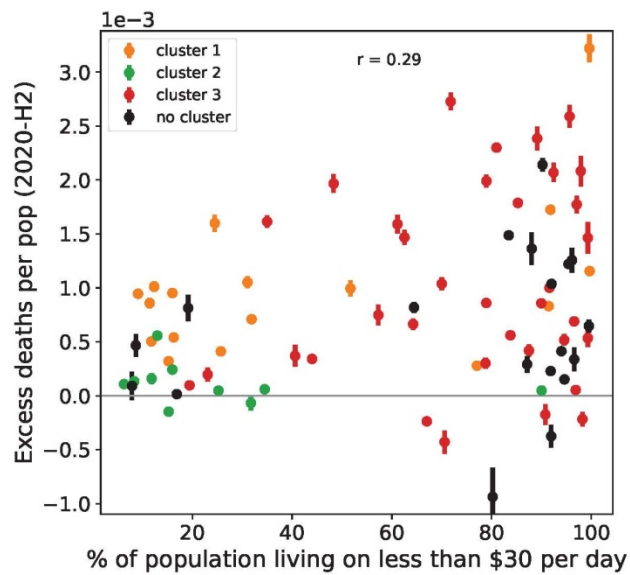
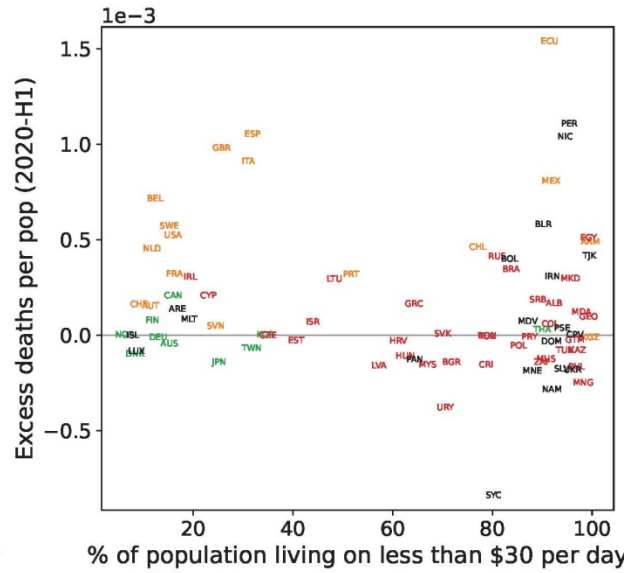
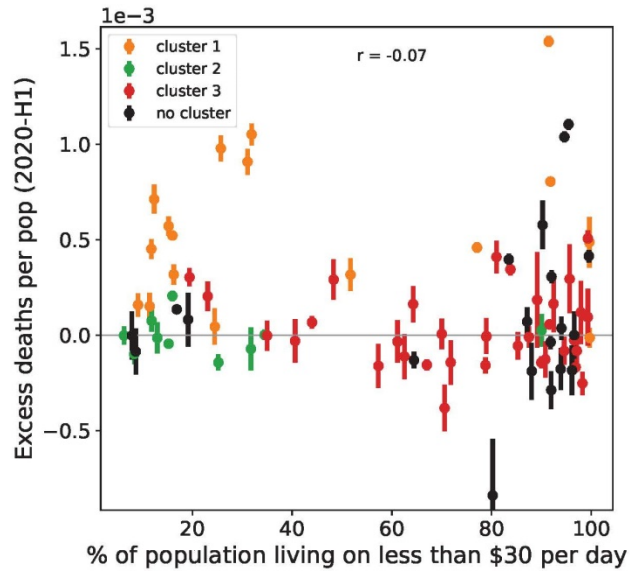
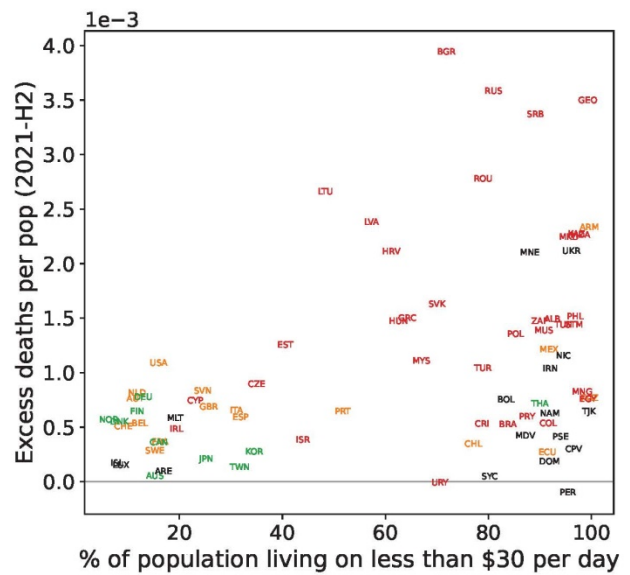
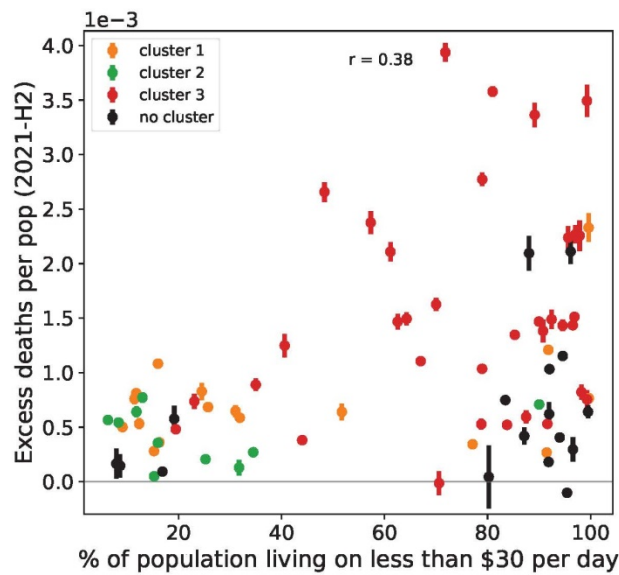
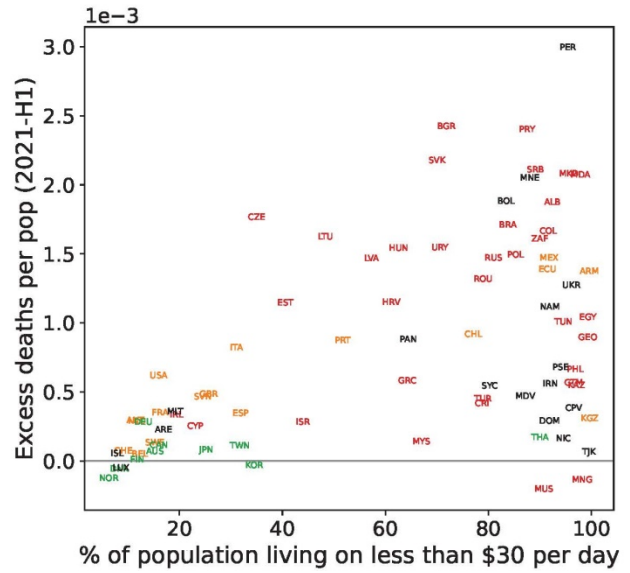
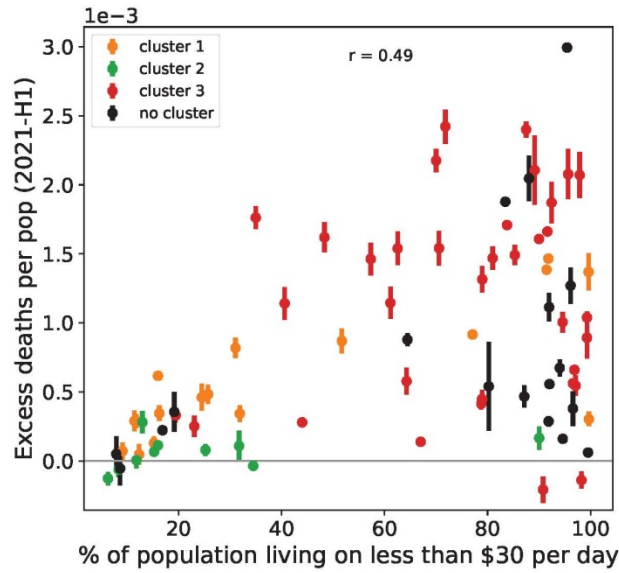
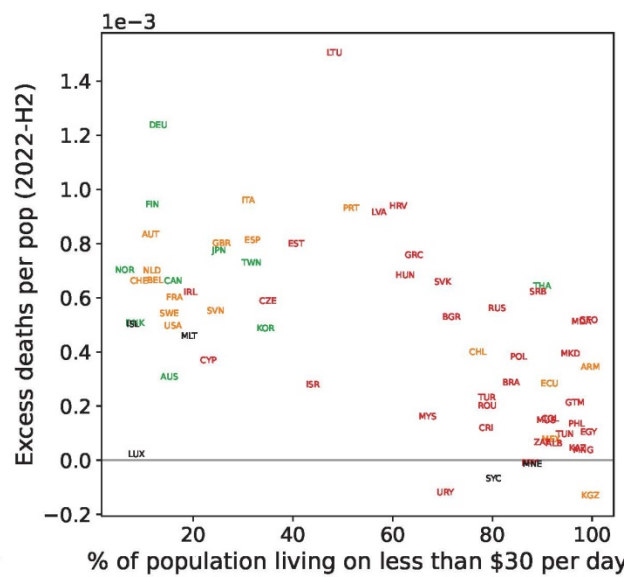
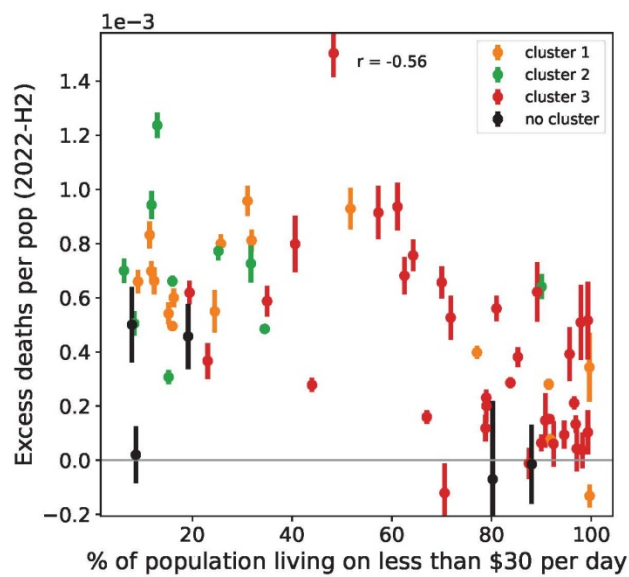
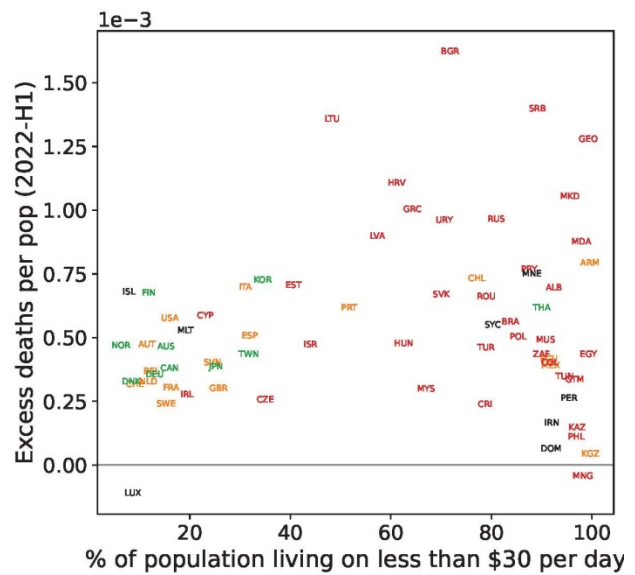
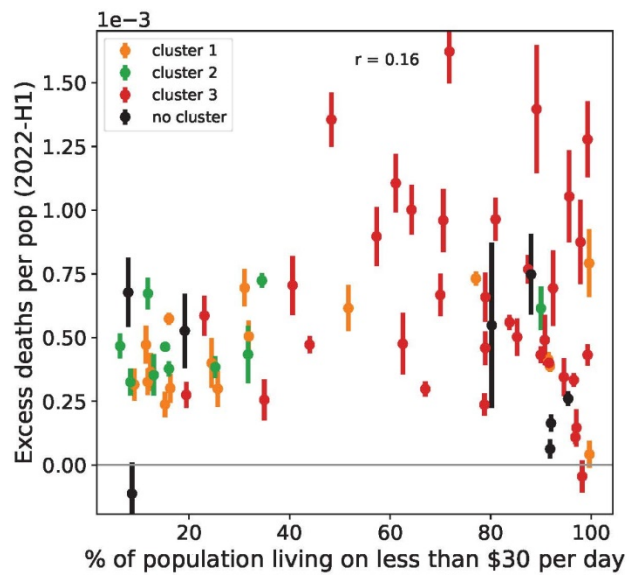


Figure 36. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus share of population living with less than \$5.50 per day, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.









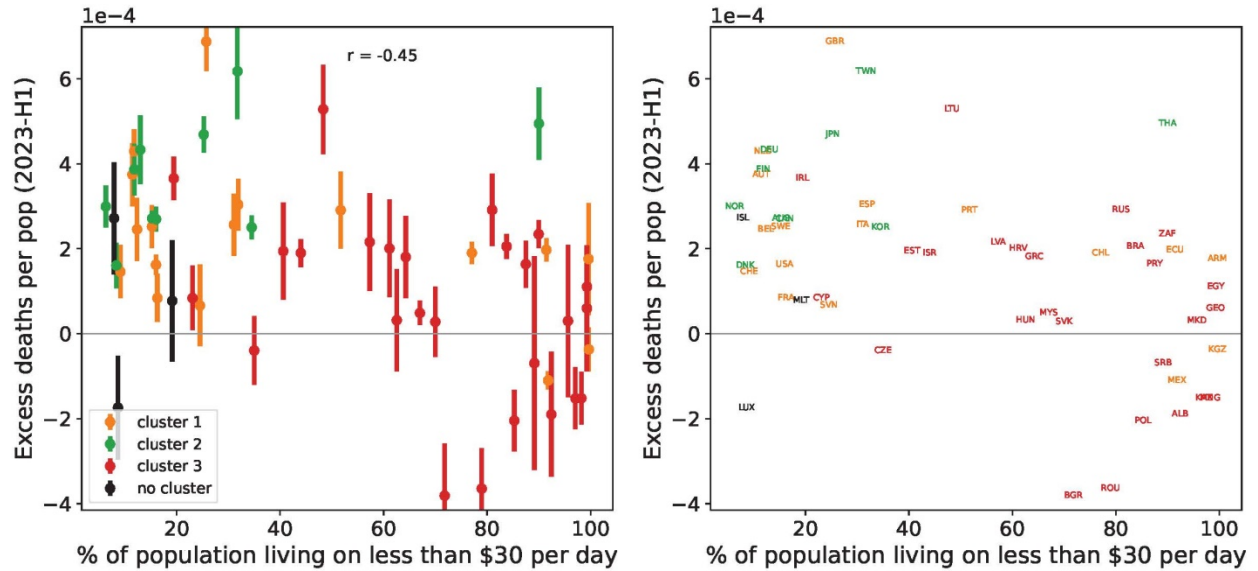
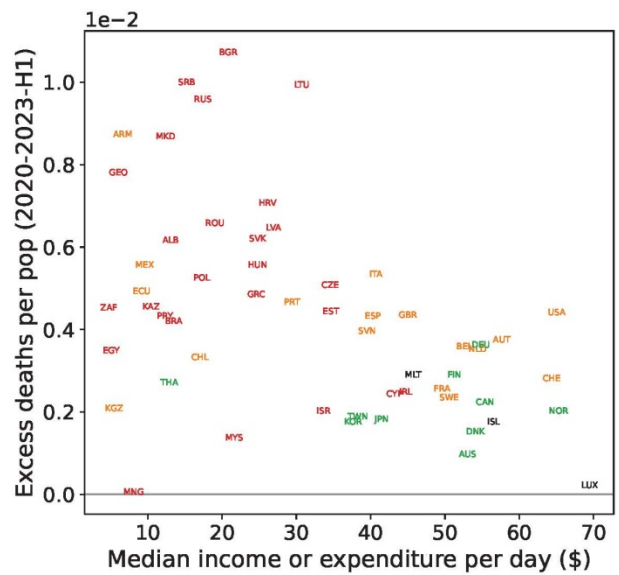
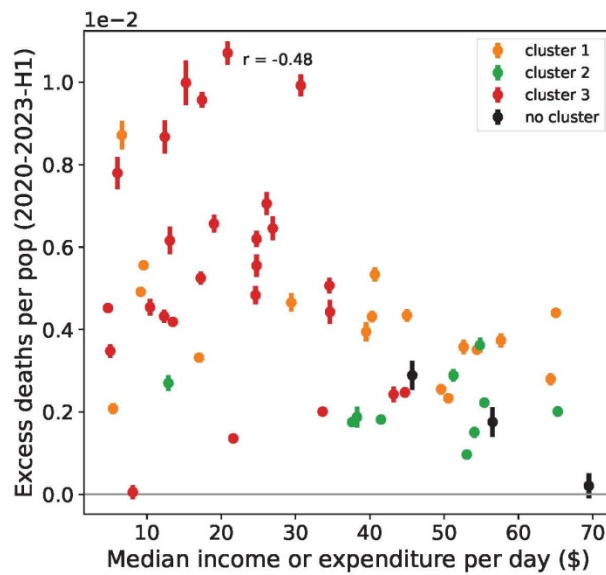
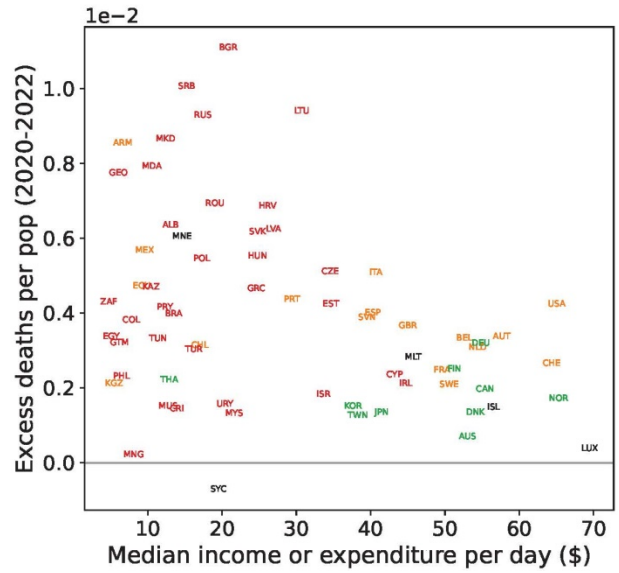
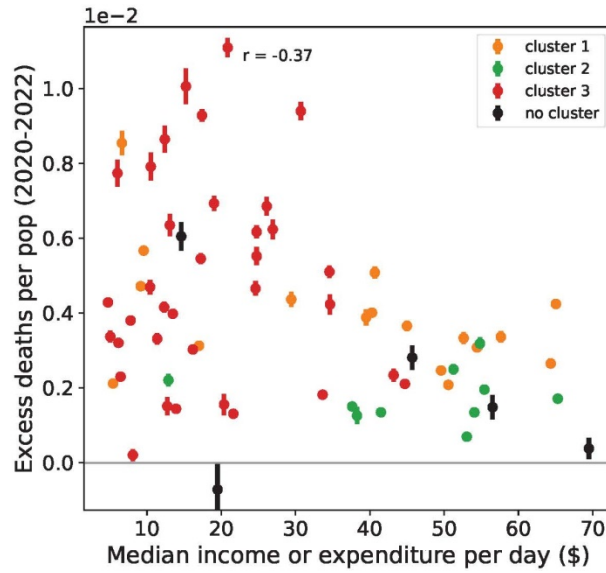
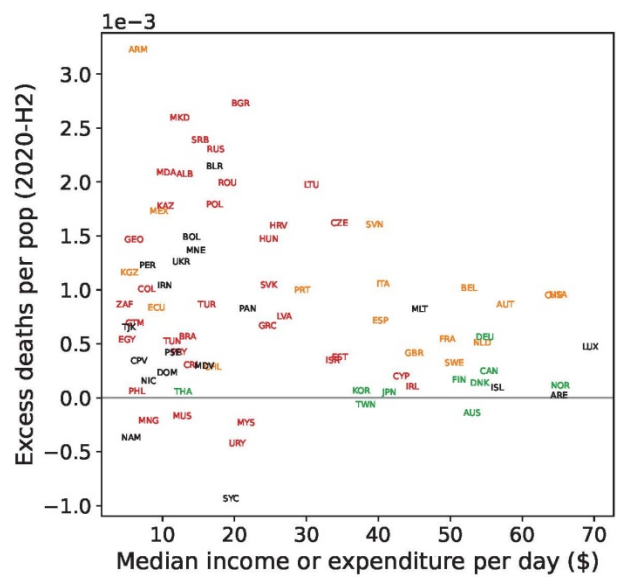
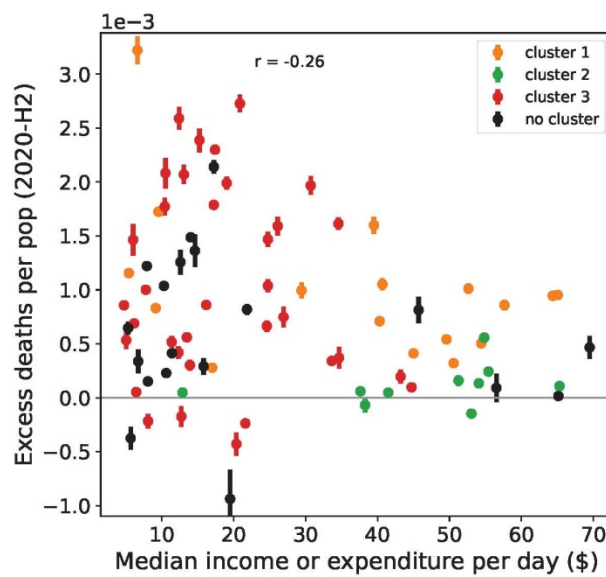
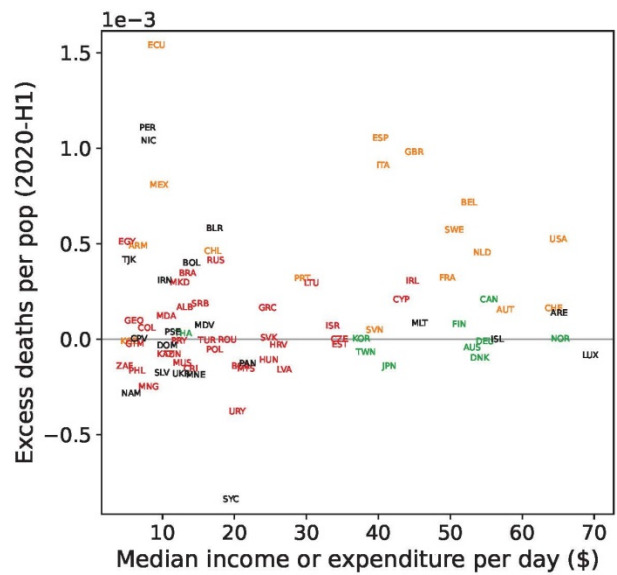
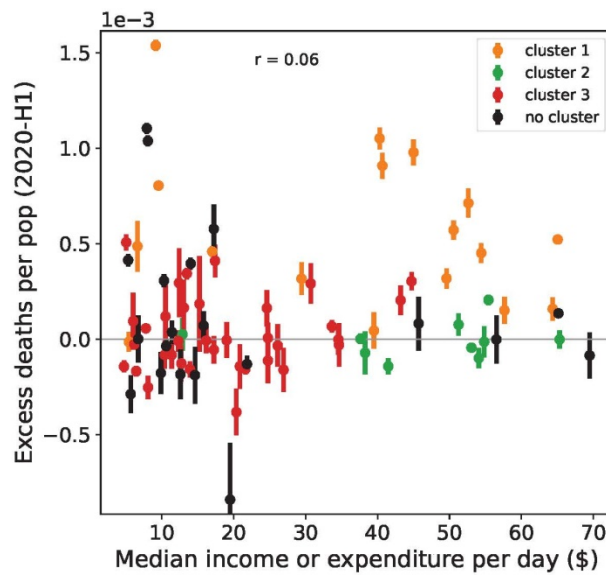
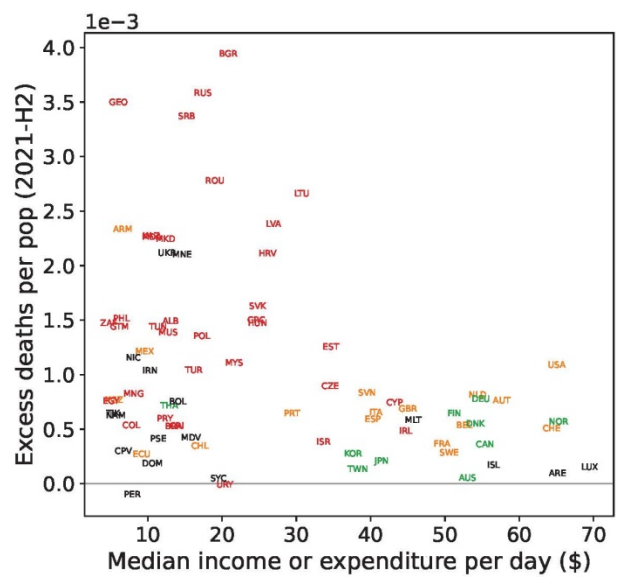
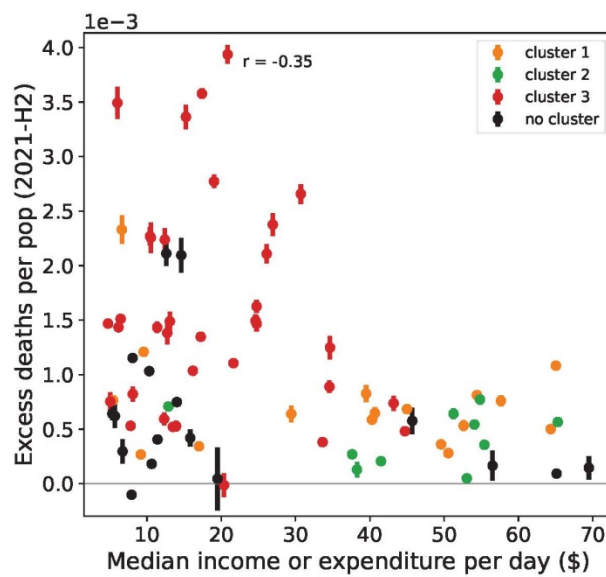
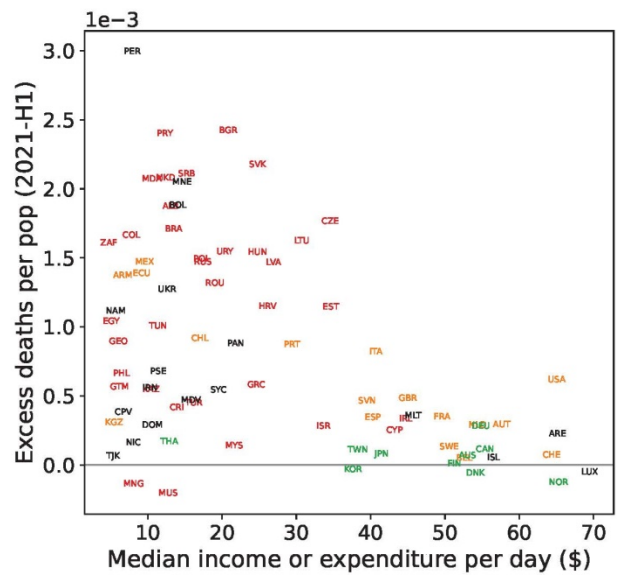
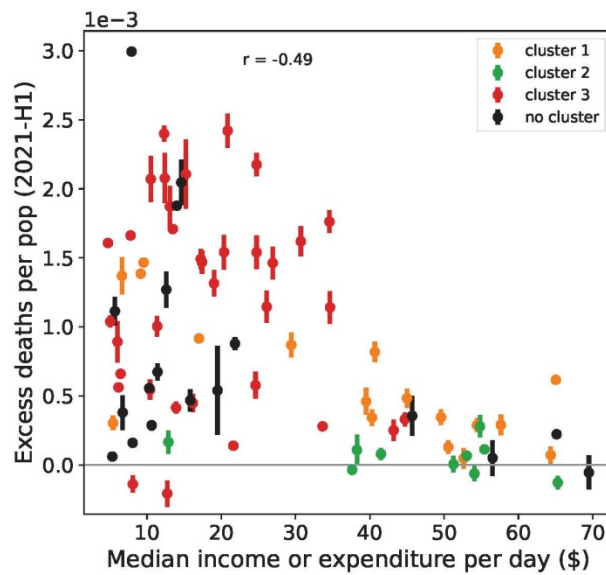
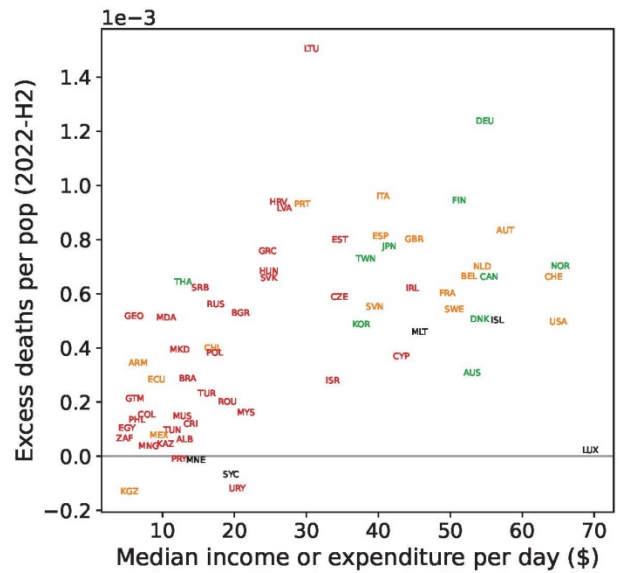
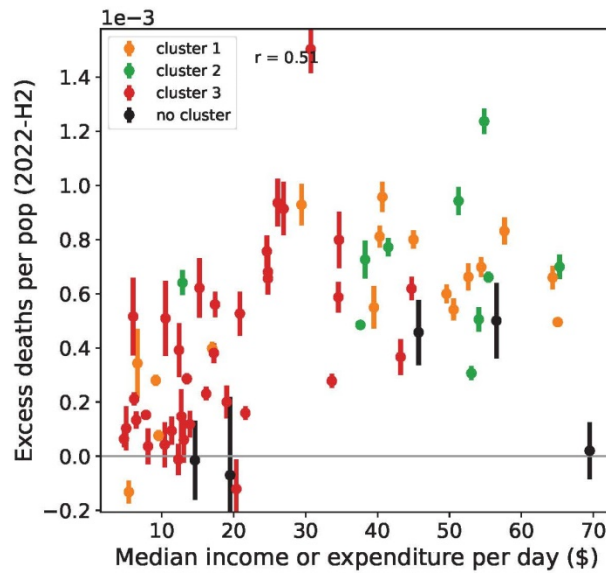
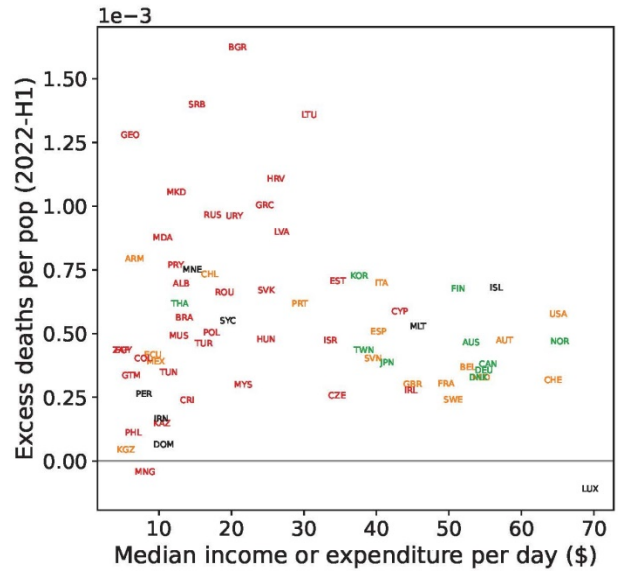
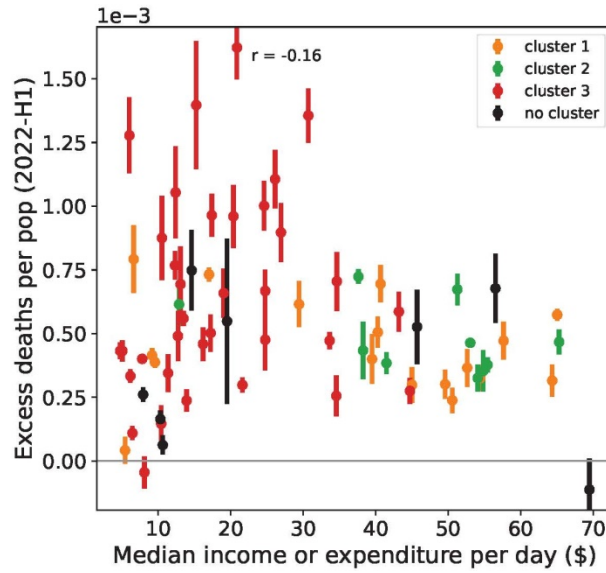


Figure 37. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus share of population living with less than \$30 per day, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.









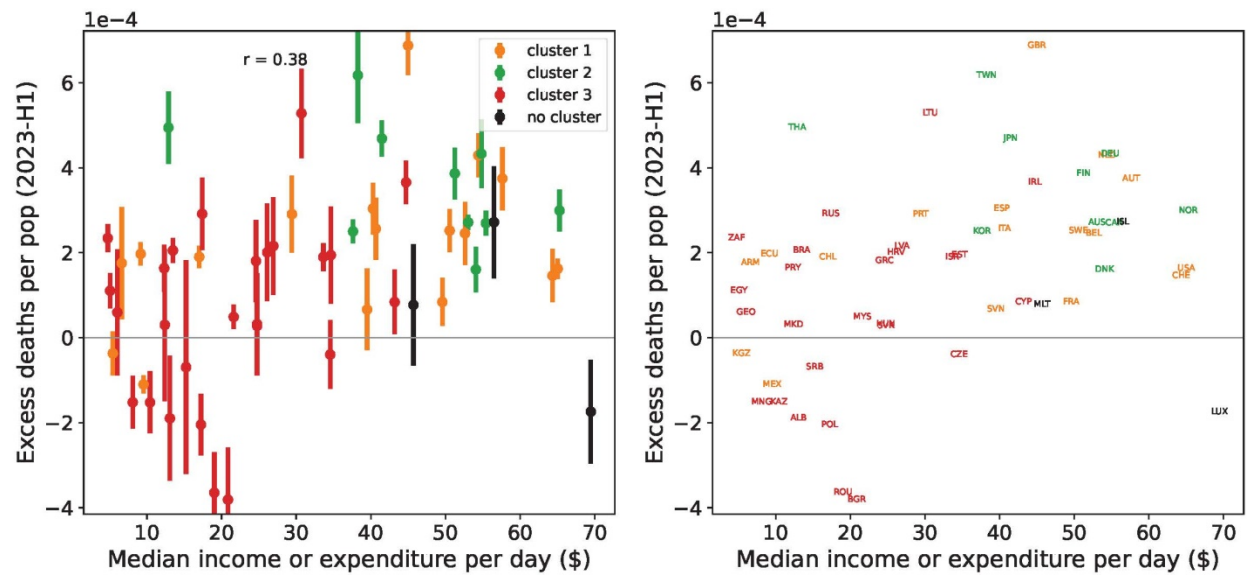
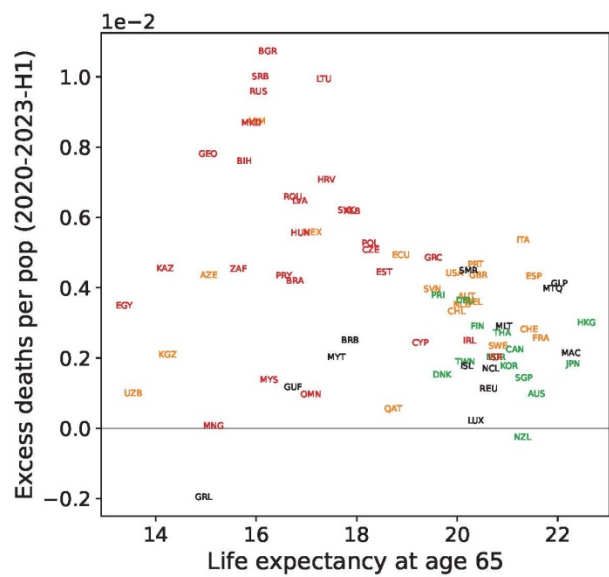
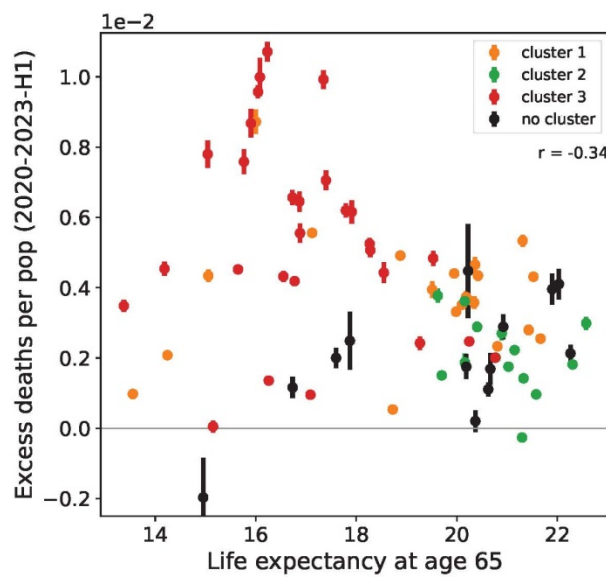
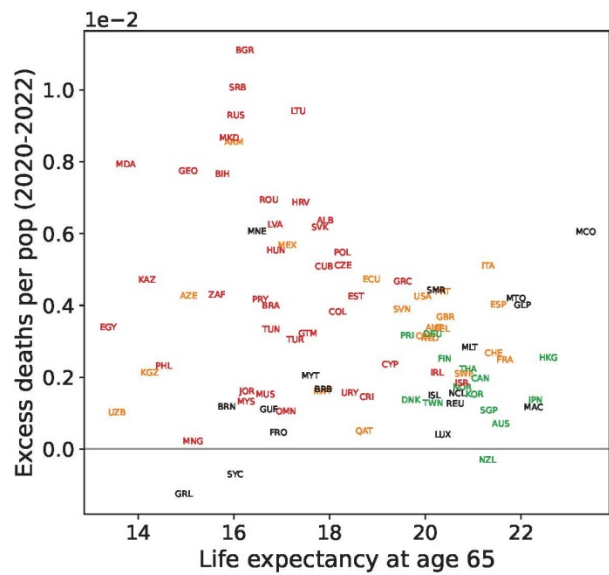
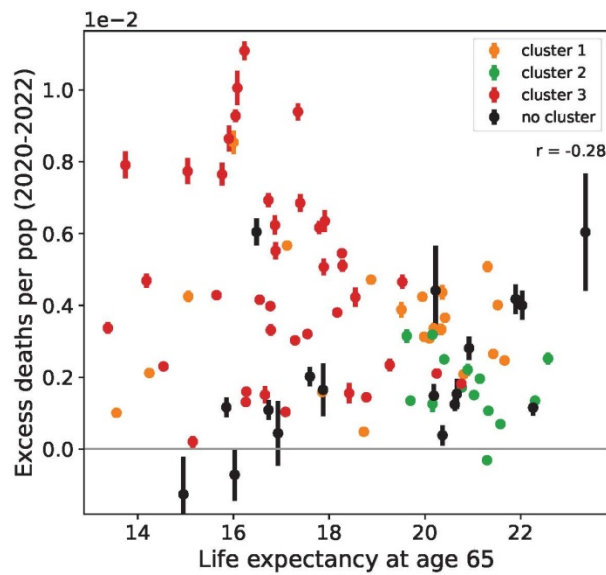
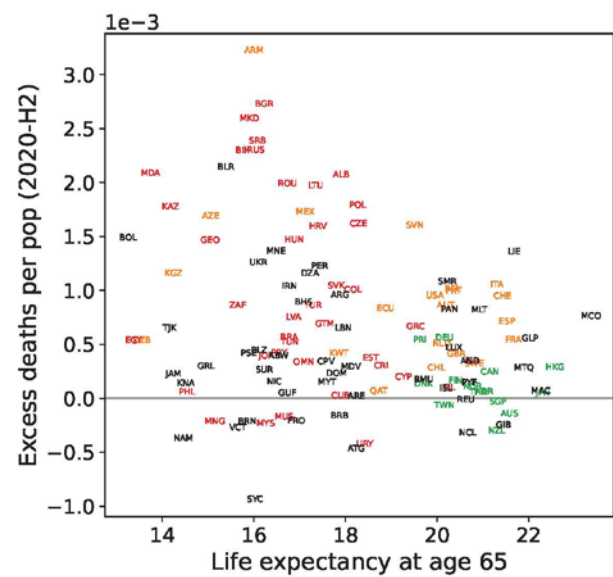
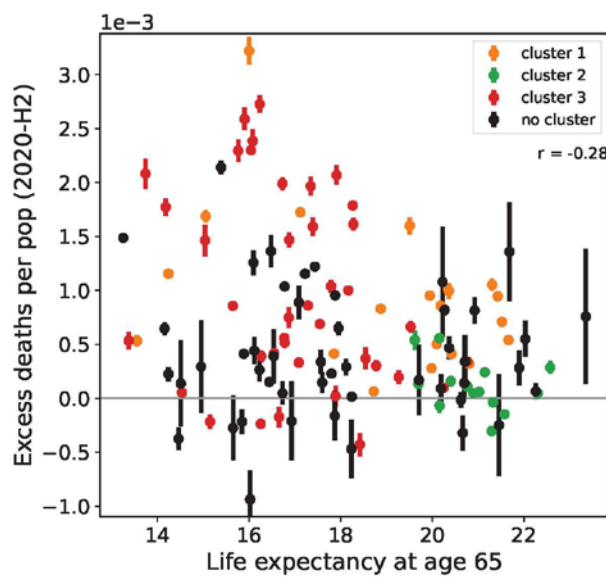
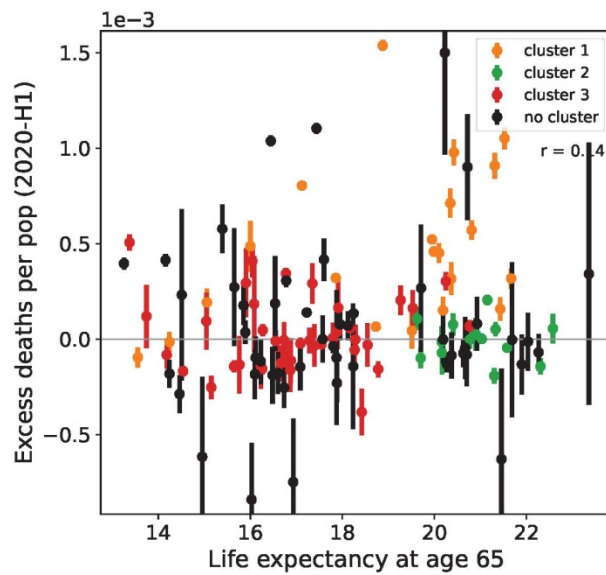
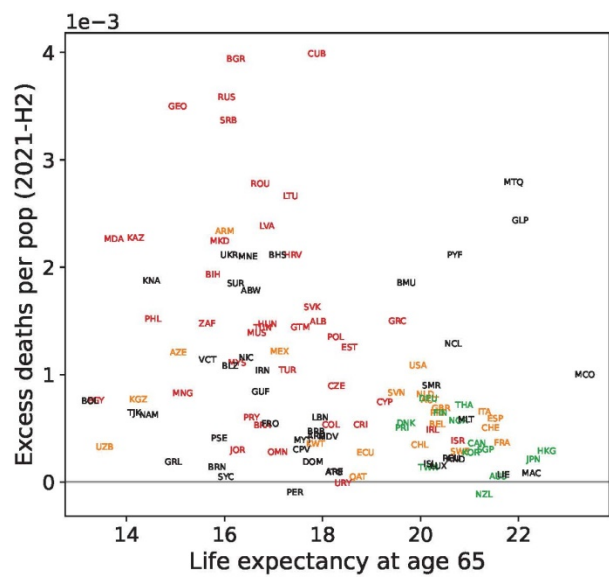
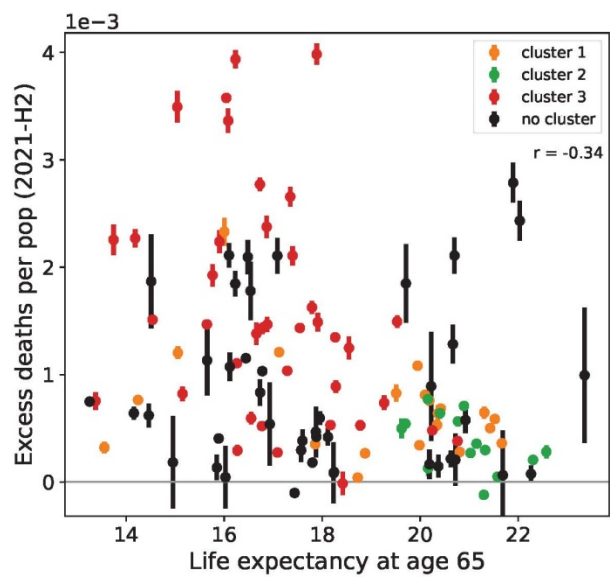
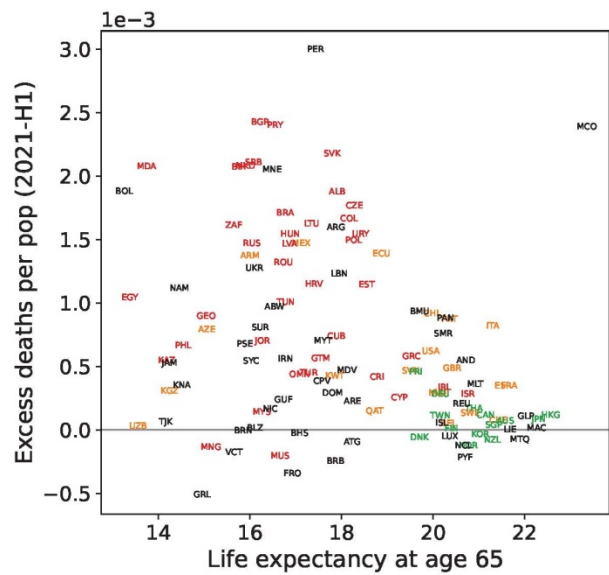
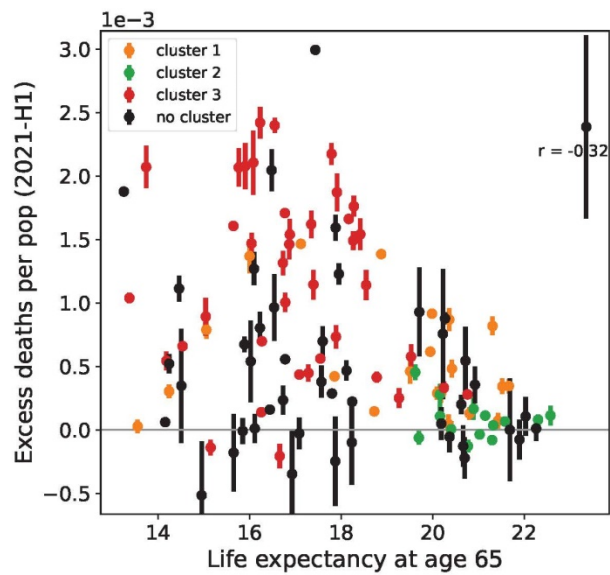
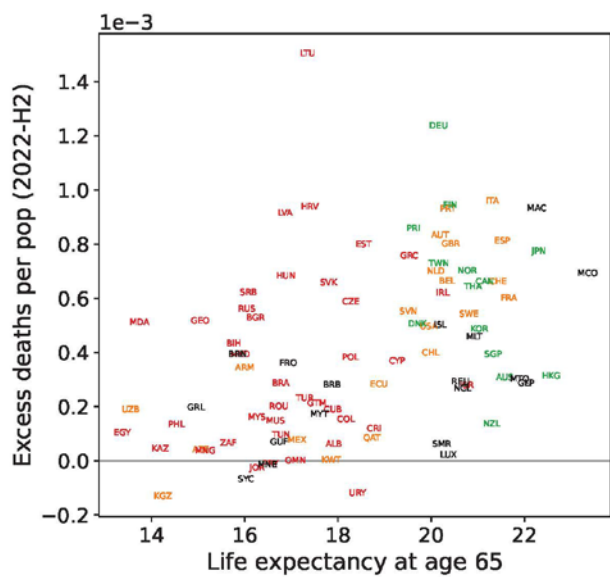
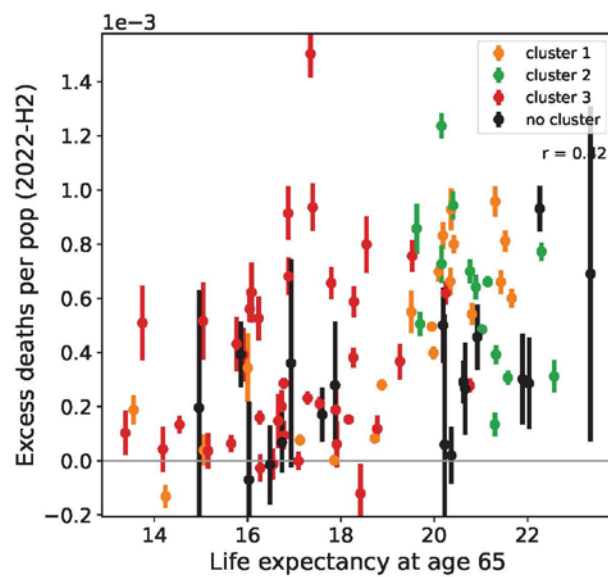
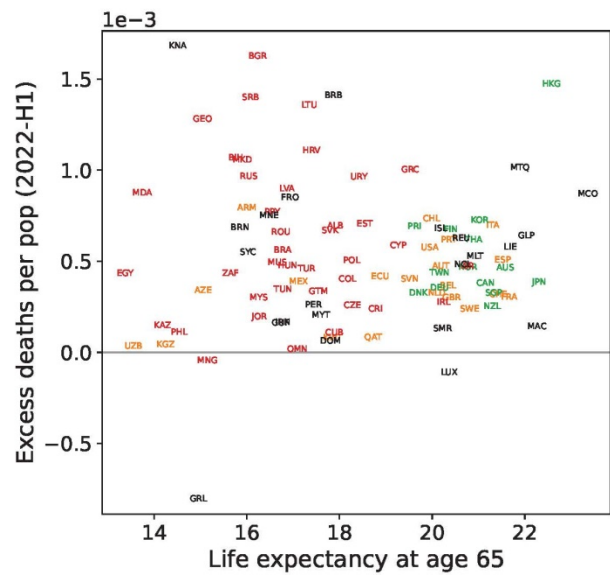
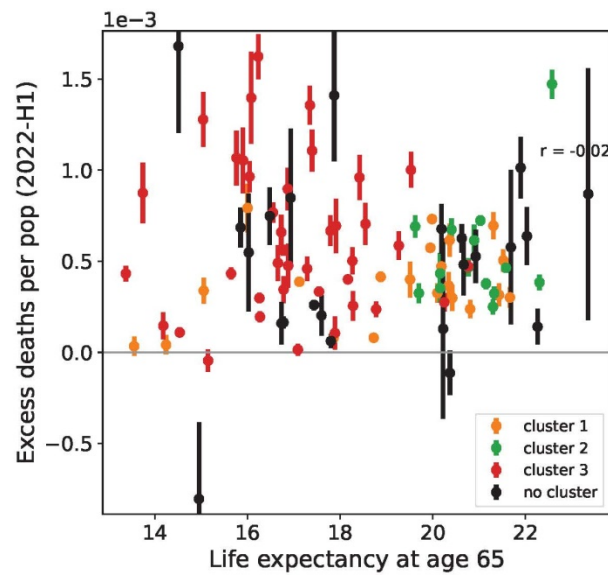


Figure 38. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus median income per day, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.









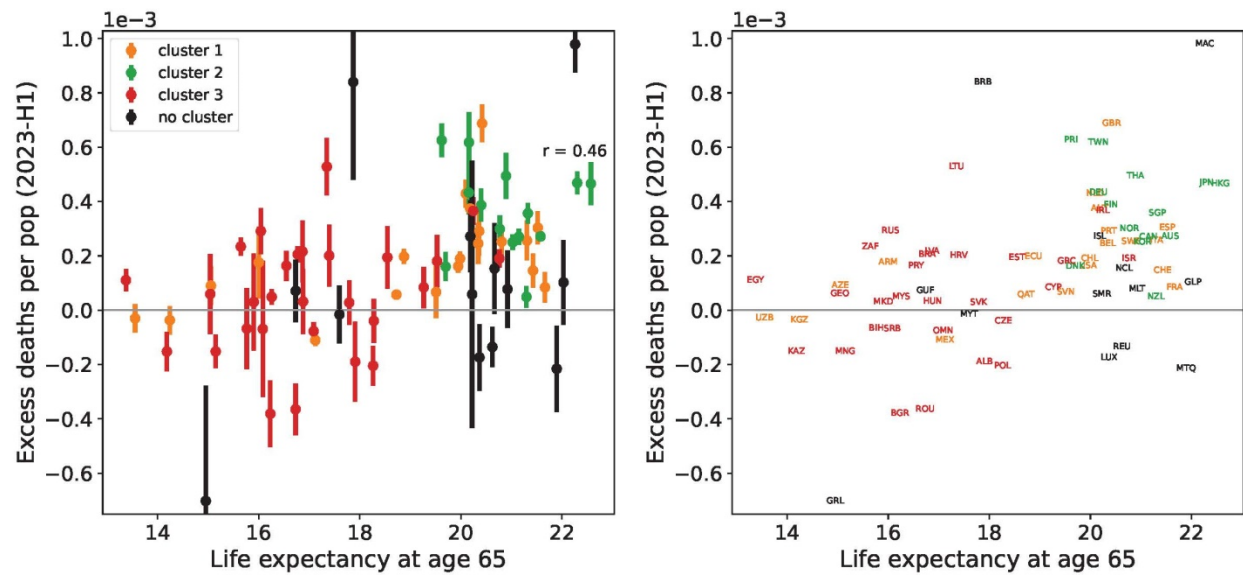
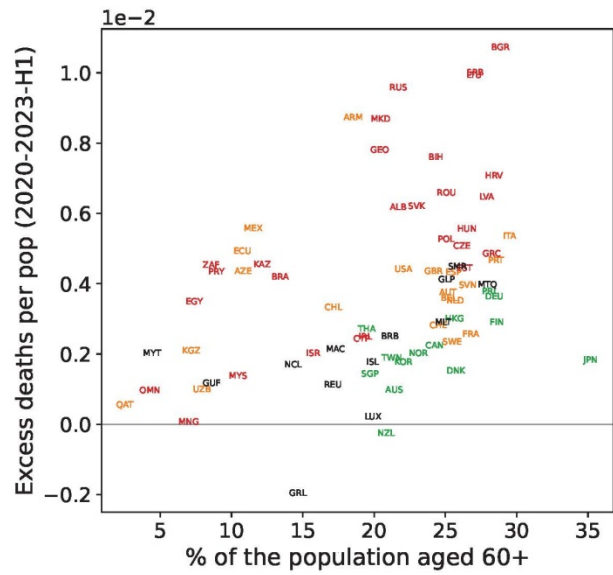
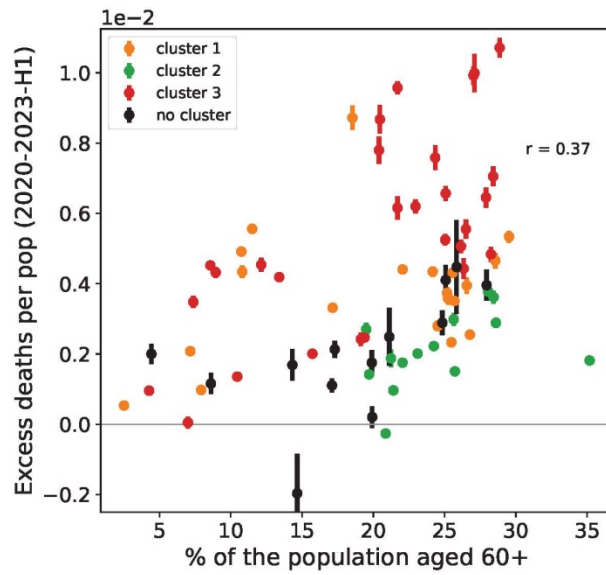
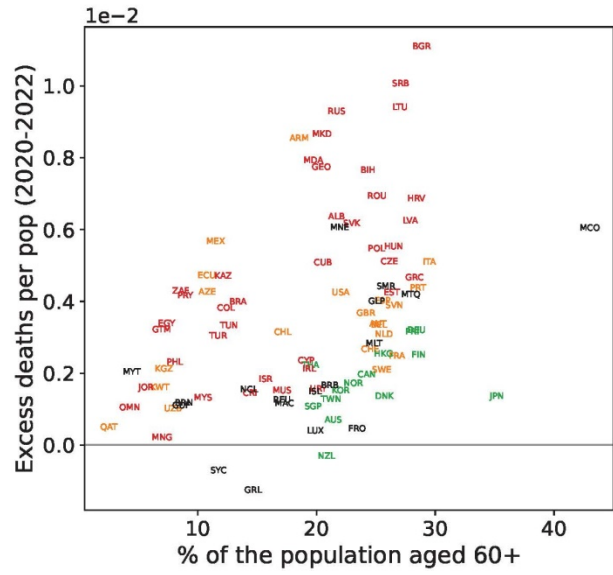
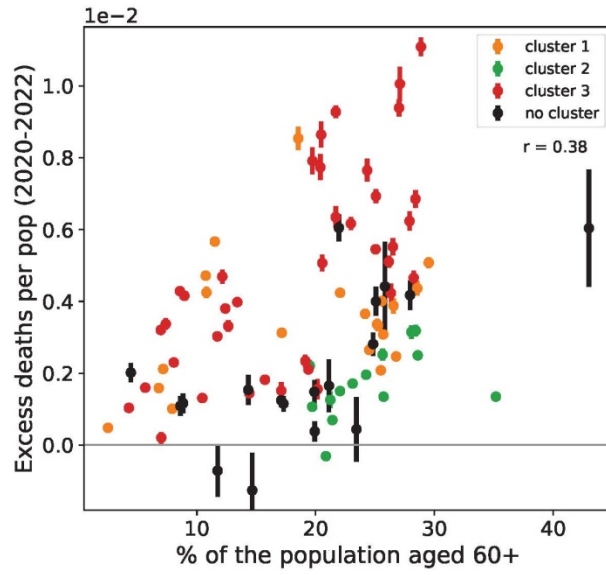
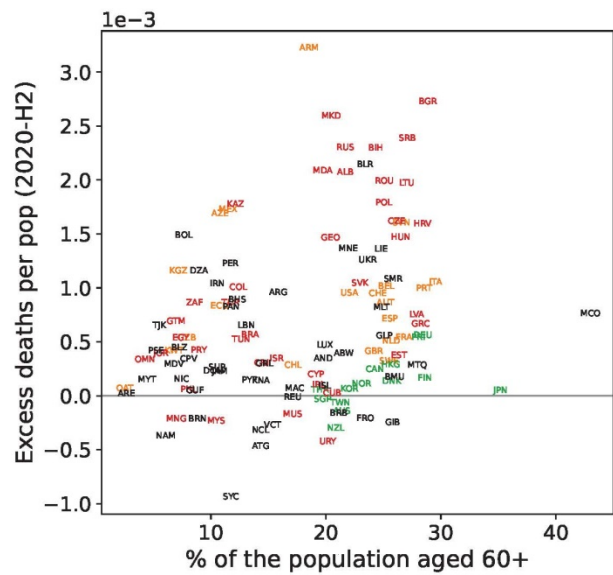
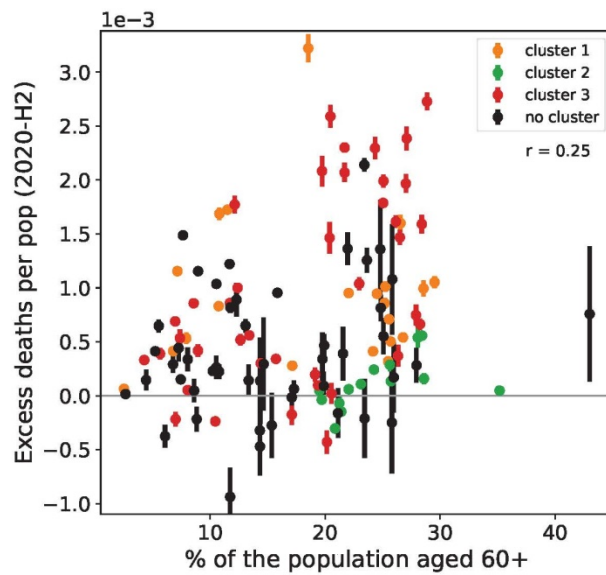
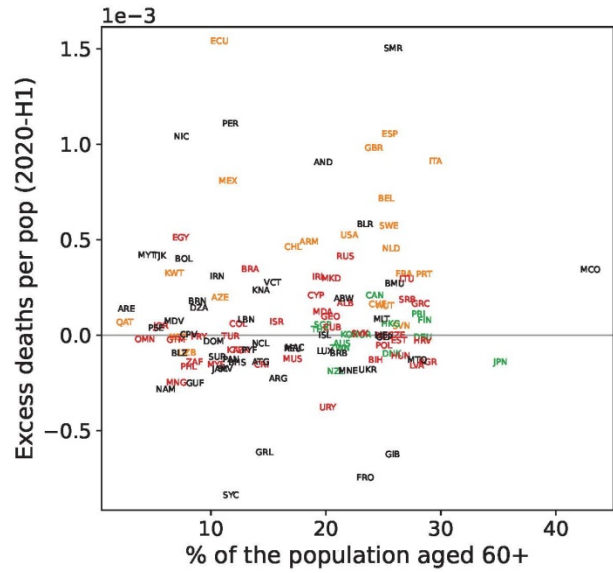
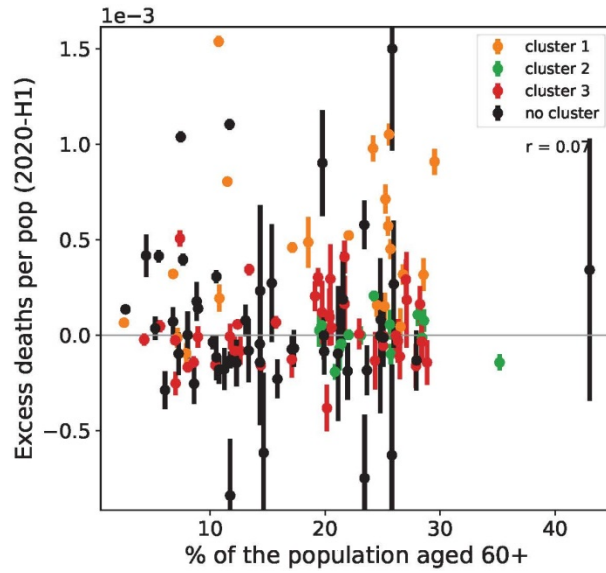
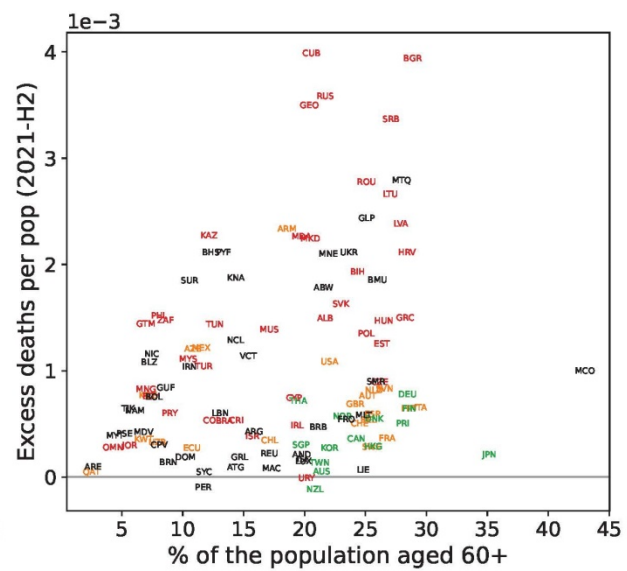
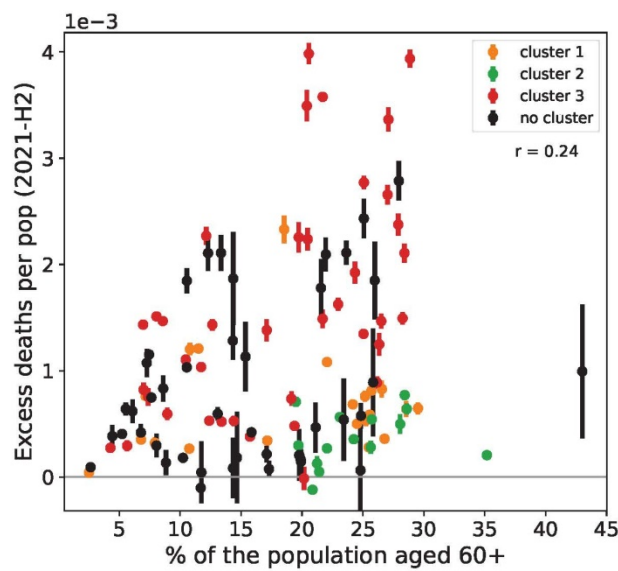
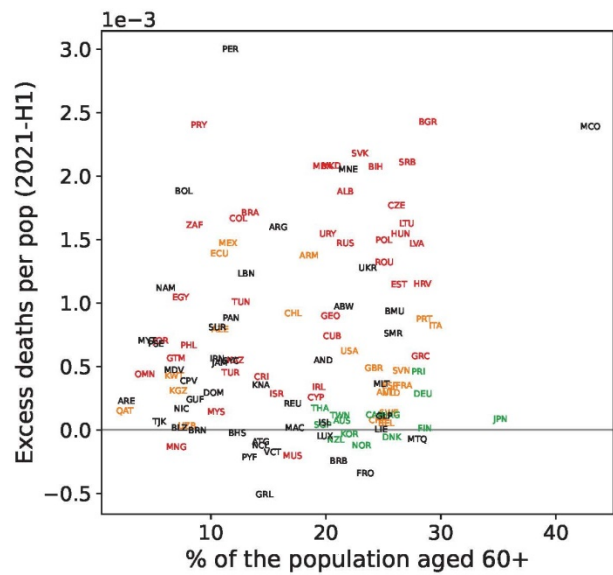
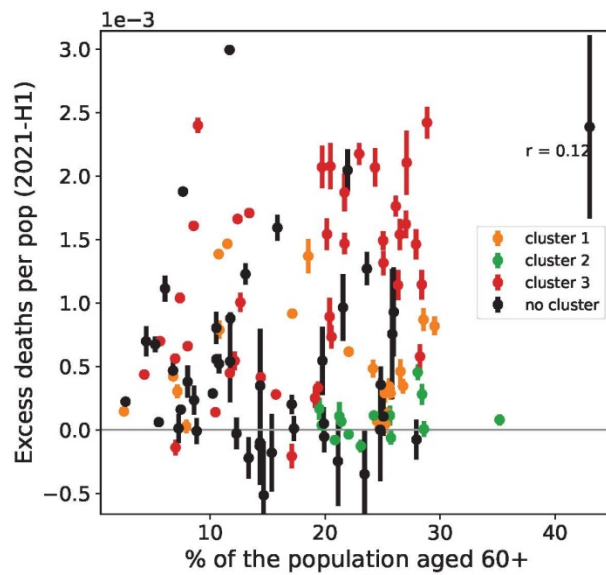
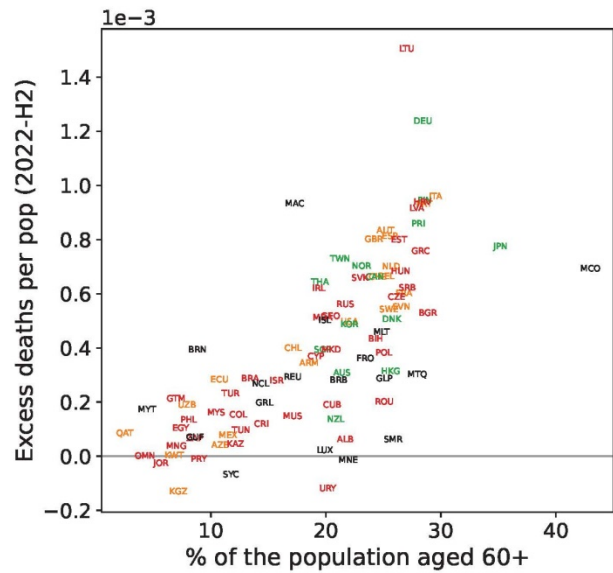
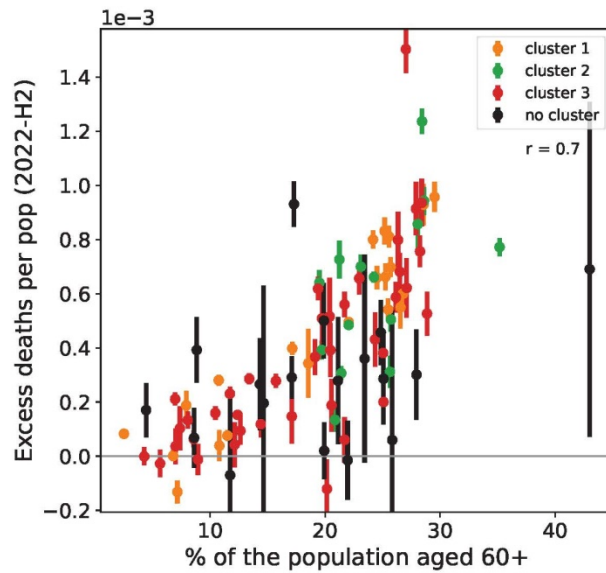
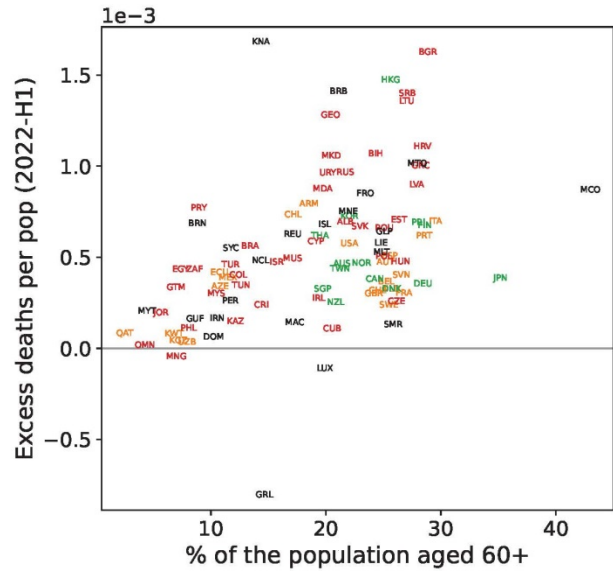
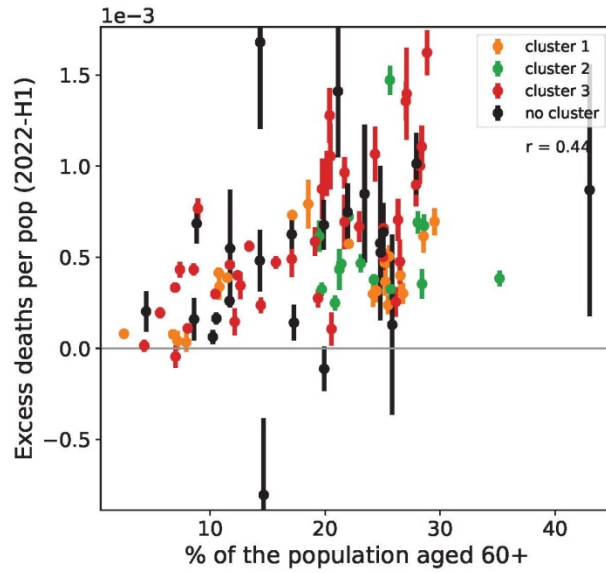


Figure 39. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus life expectancy at age 65, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.









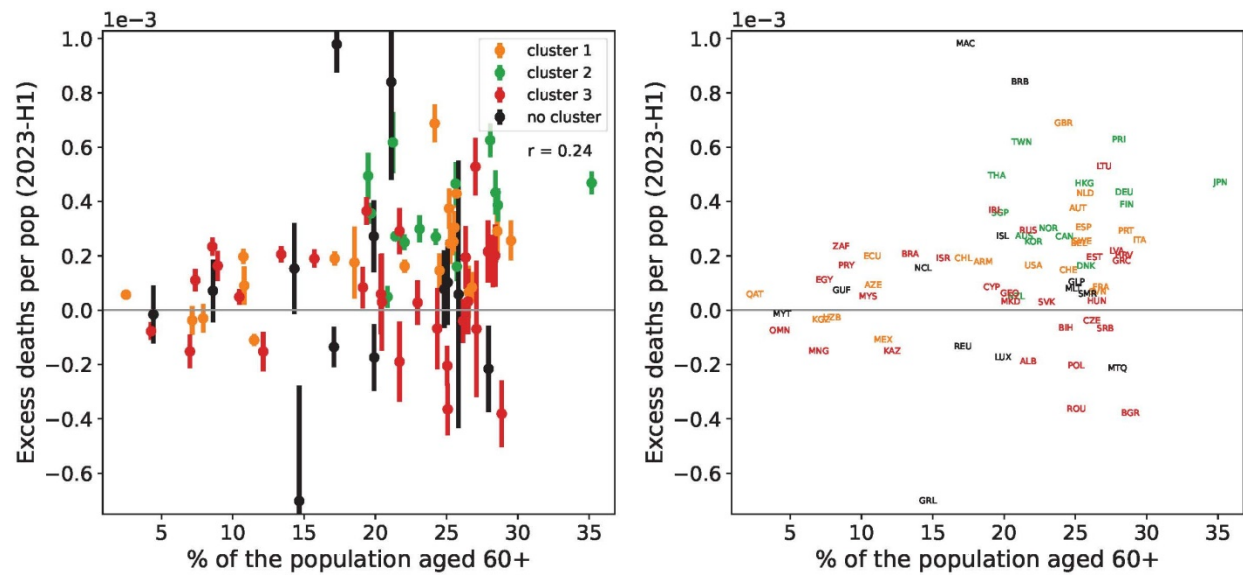
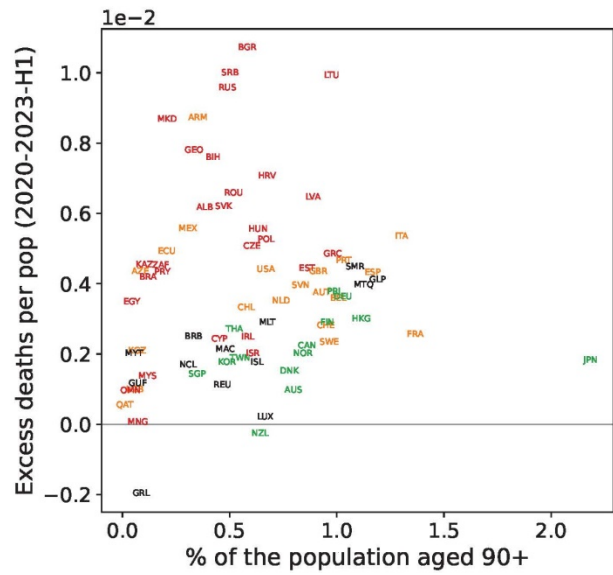
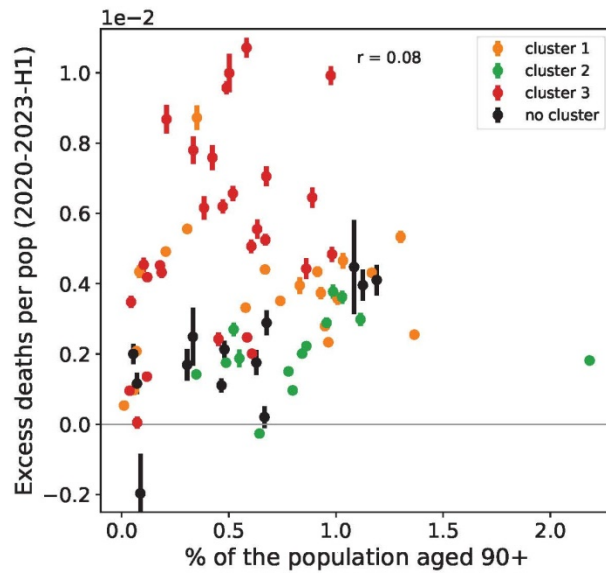
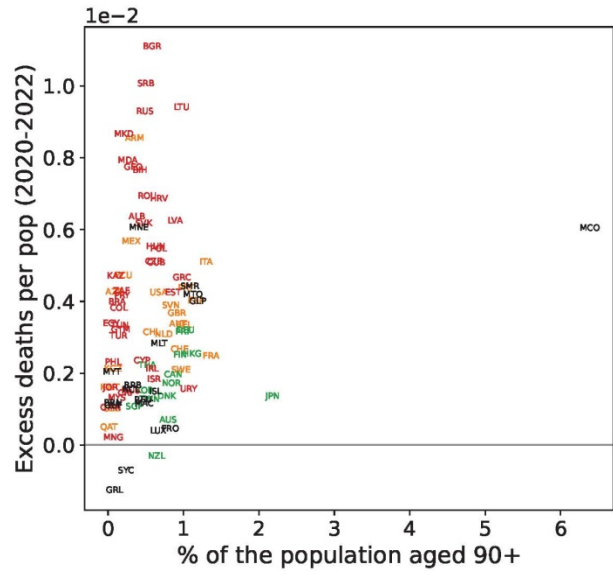
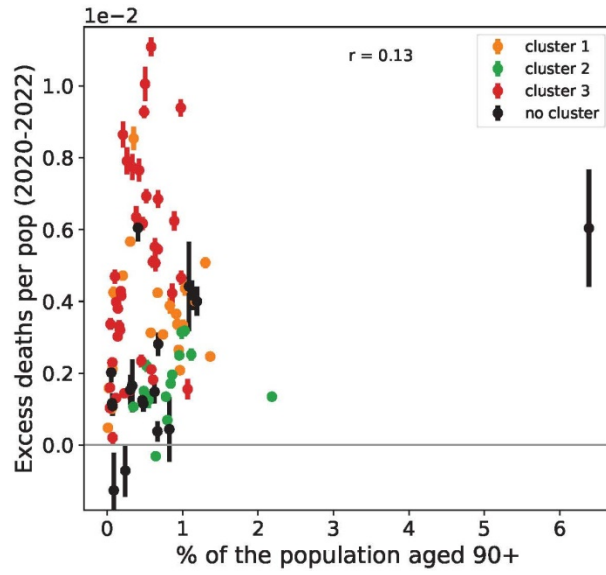
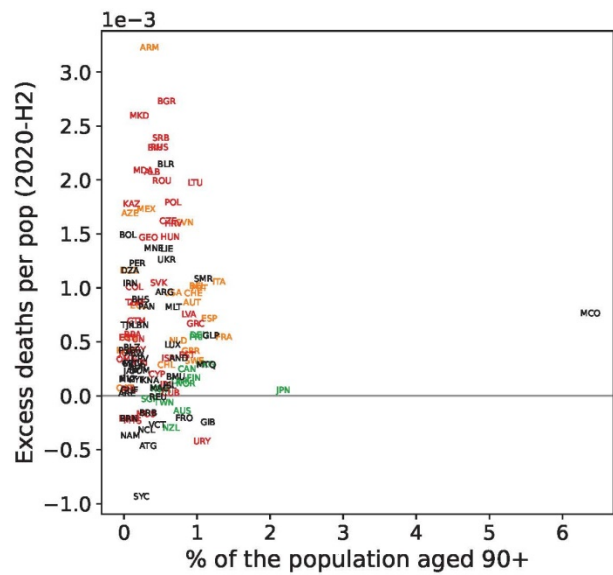
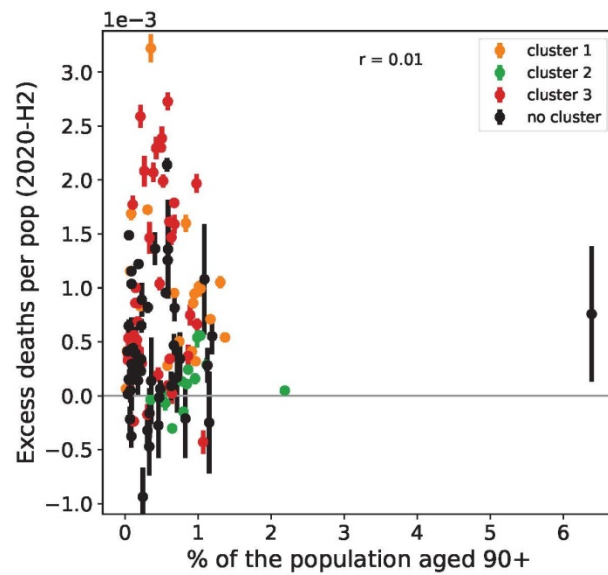
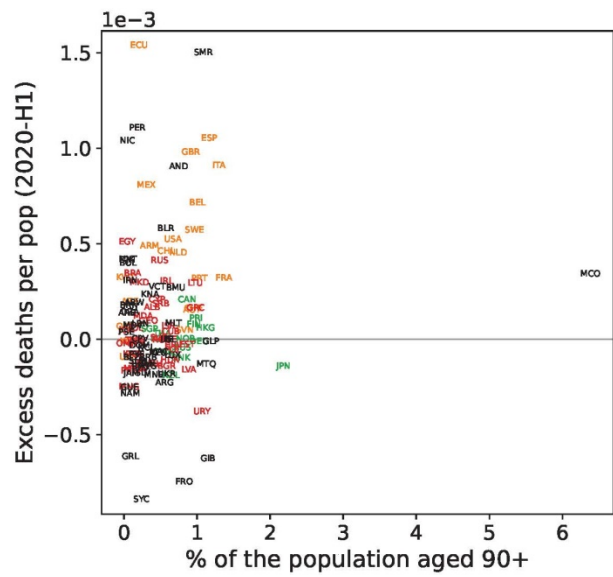
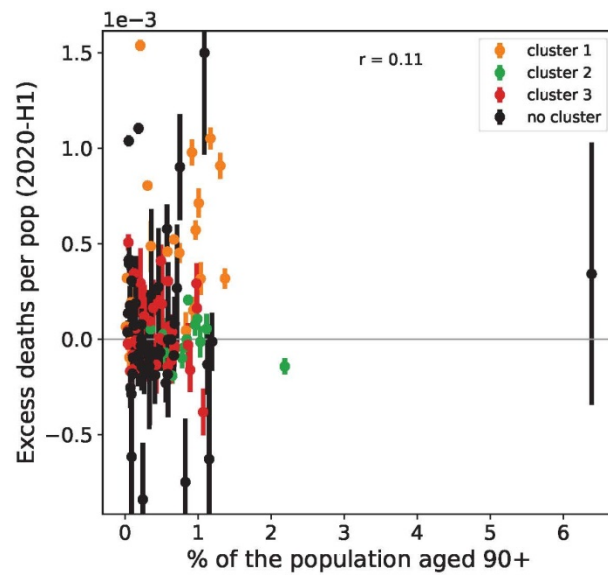
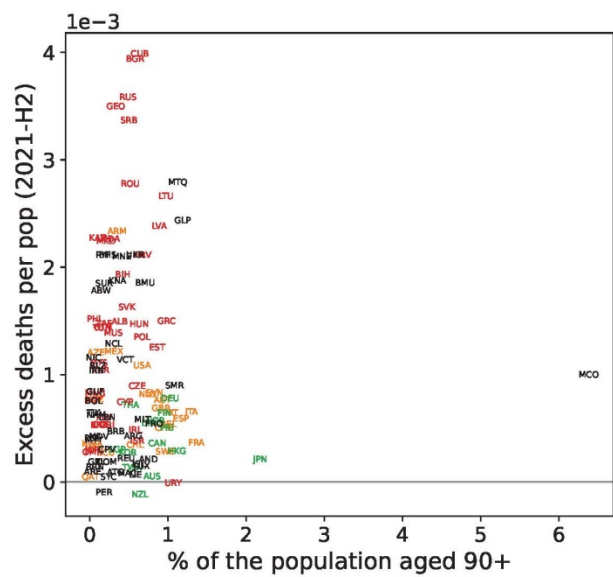
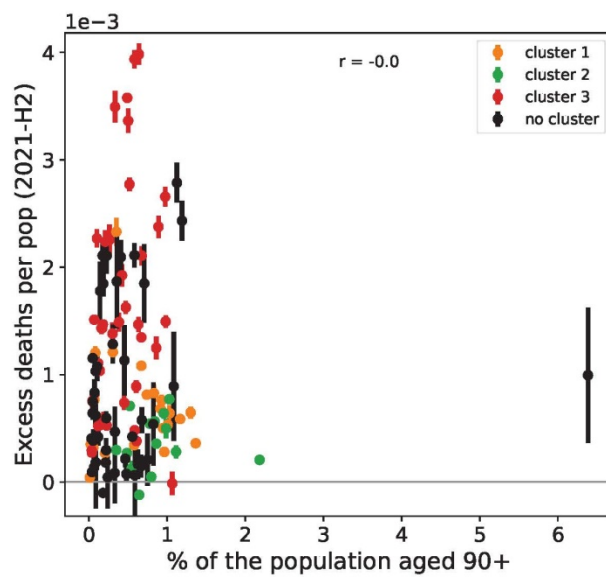
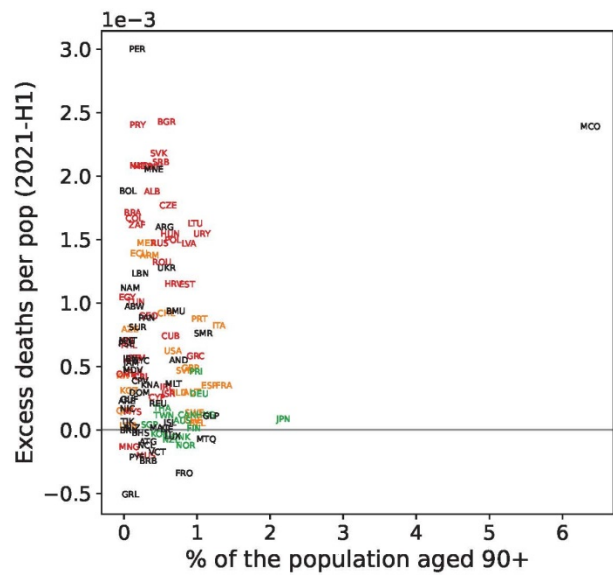
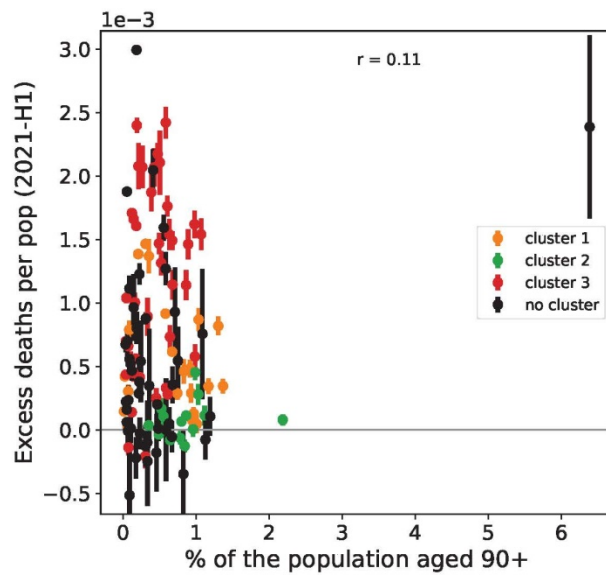
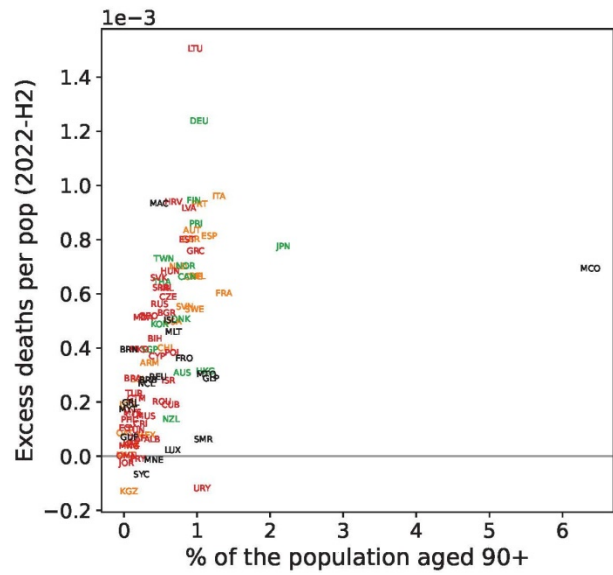
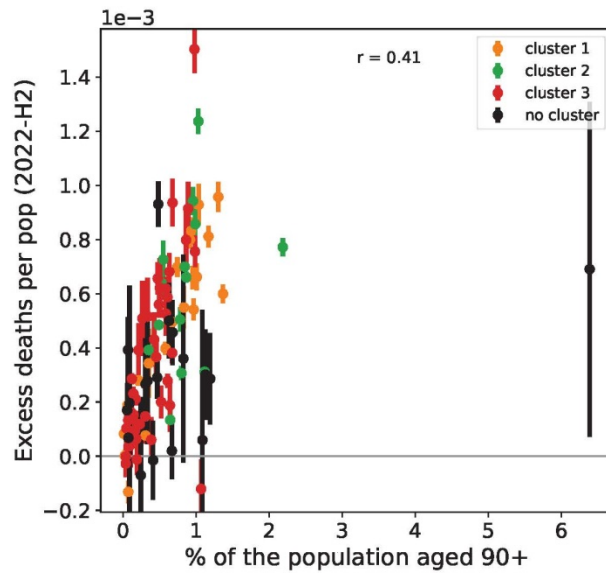
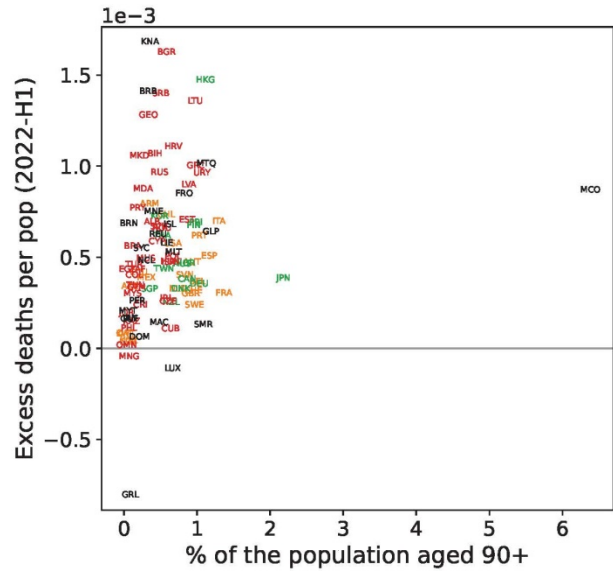
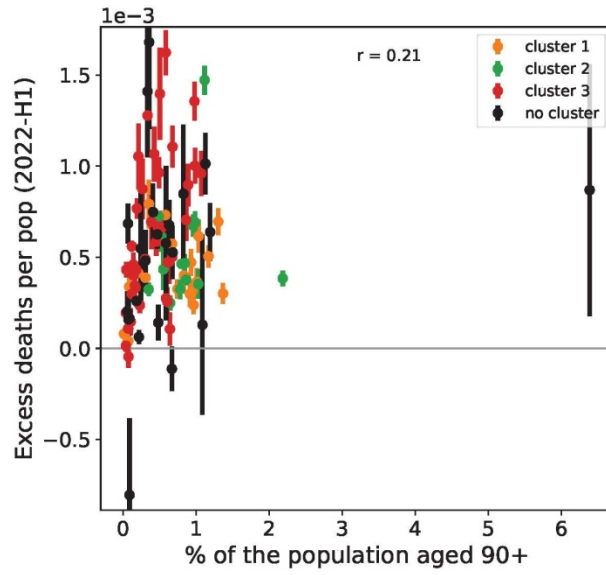


Figure 40. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus share of population aged 60+, with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.









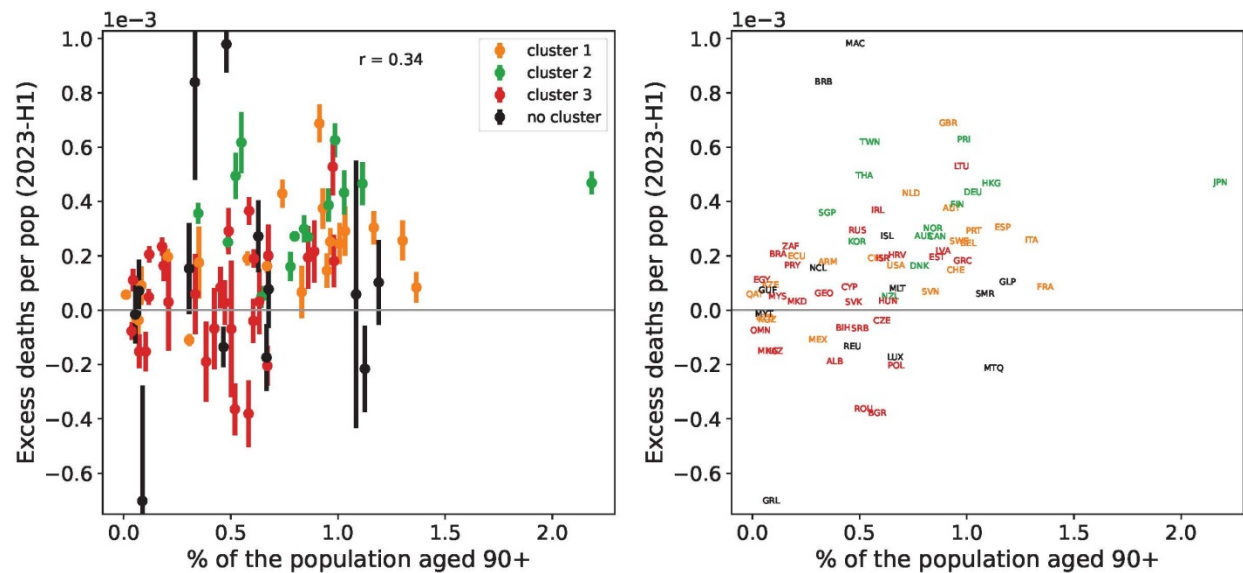


Figure 41. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus share of population aged 90+, with 1 σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.

4.17 Excess all-cause mortality correlations with vaccination by population

The number of vaccine injections by population for a given vaccination period, like socio-economic variables, is itself a variable. We consider the vaccination periods 2021-2022, 2021, and 2022.

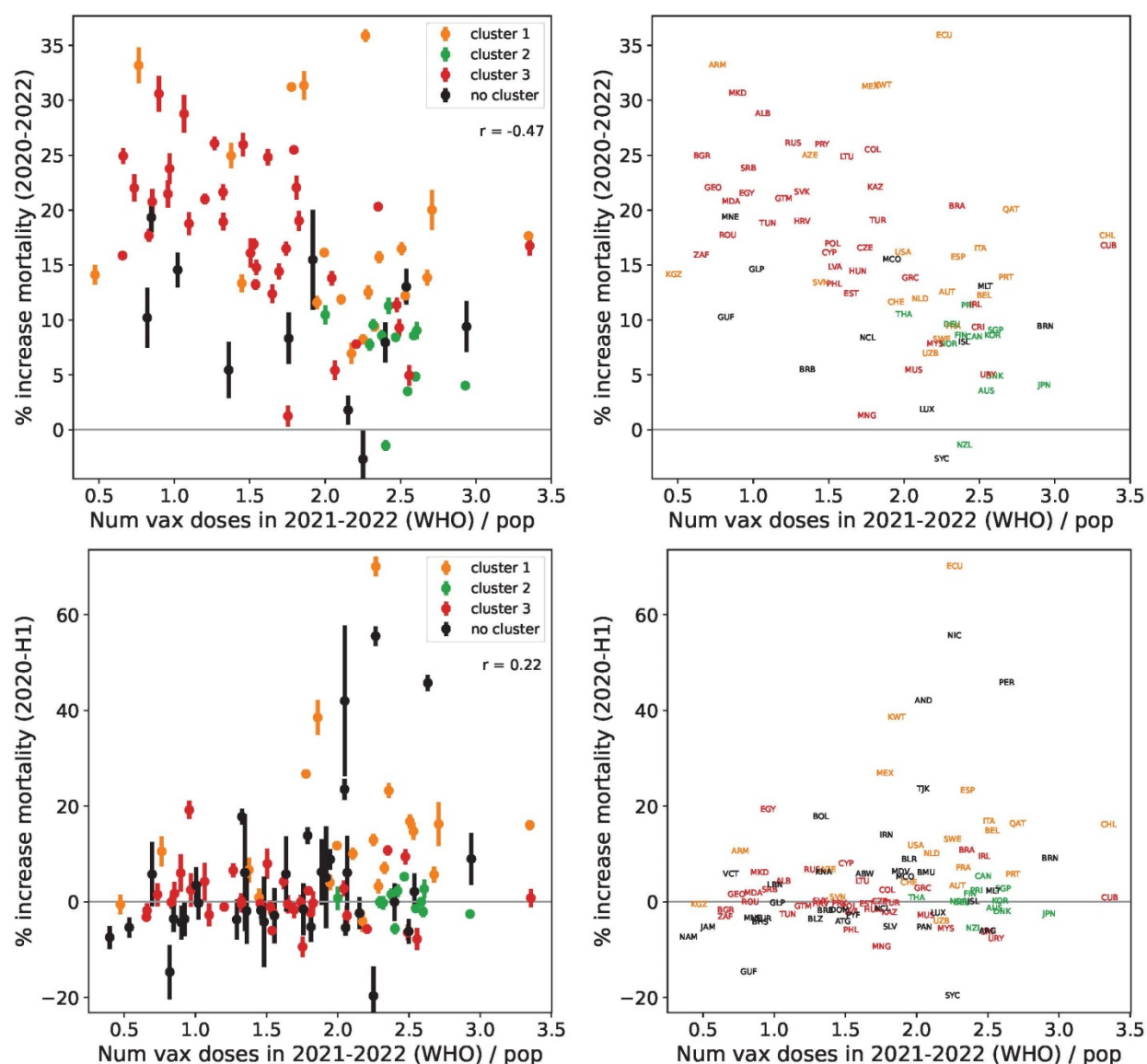
We showed above that vaccination by population is correlated to poverty or wealth variables, and to other socio-economic variables (Figure 25).

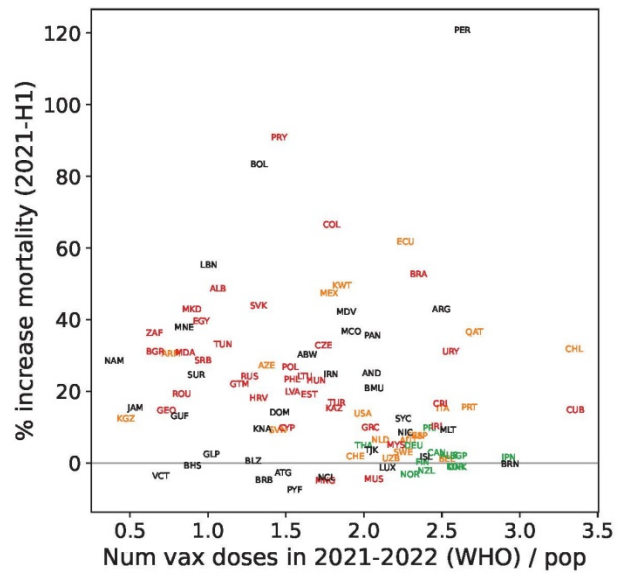
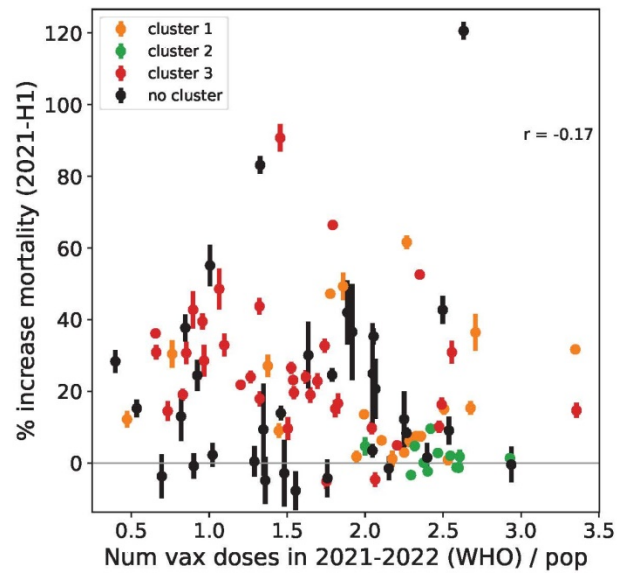
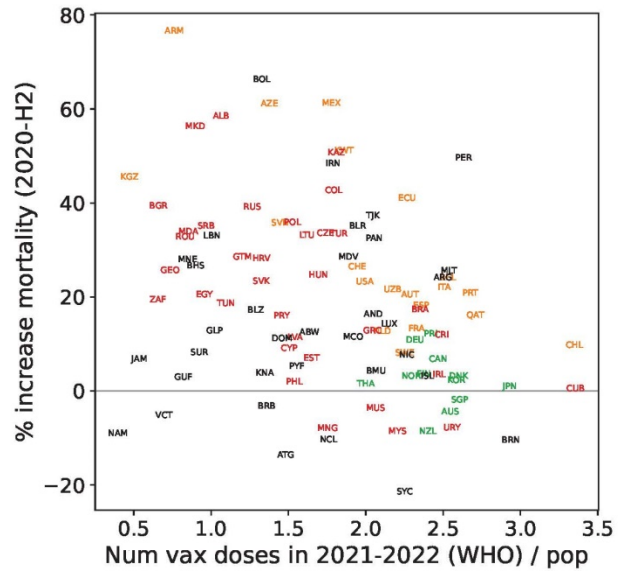
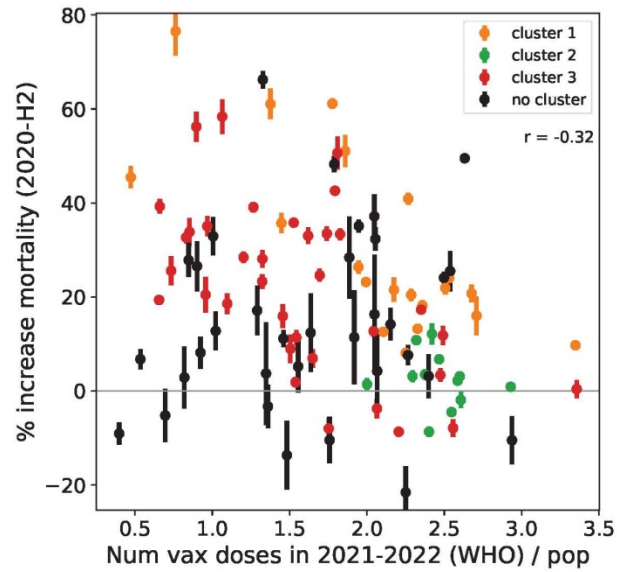
The main results of the correlations between excess all-cause mortality during the Covid period and vaccine injections (WHO data) by population for given vaccination periods are shown in the figures below, for vaccination periods 2021-2022, 2021, and 2022. In

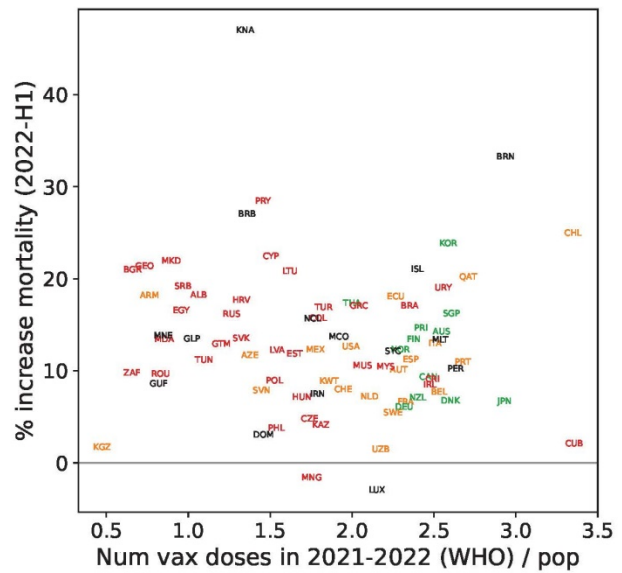
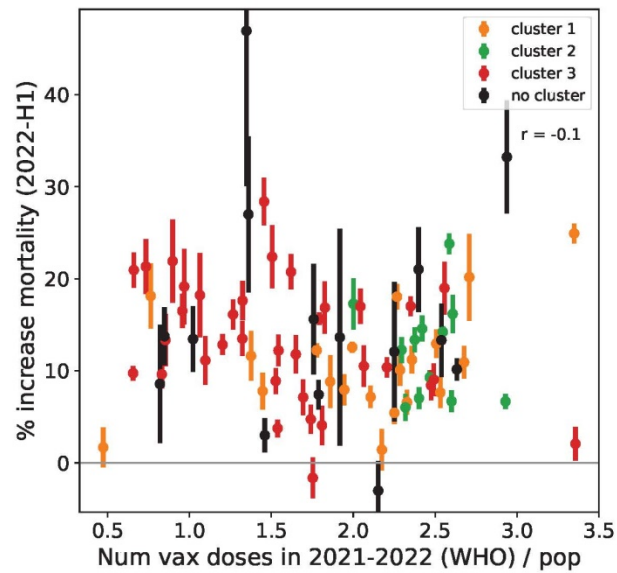
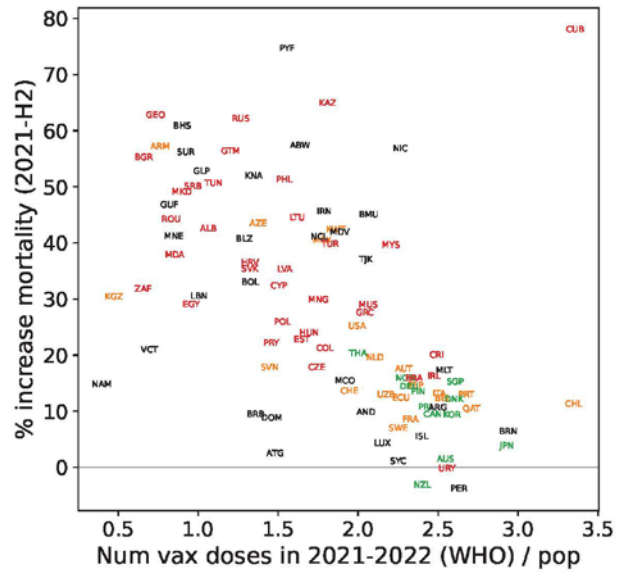
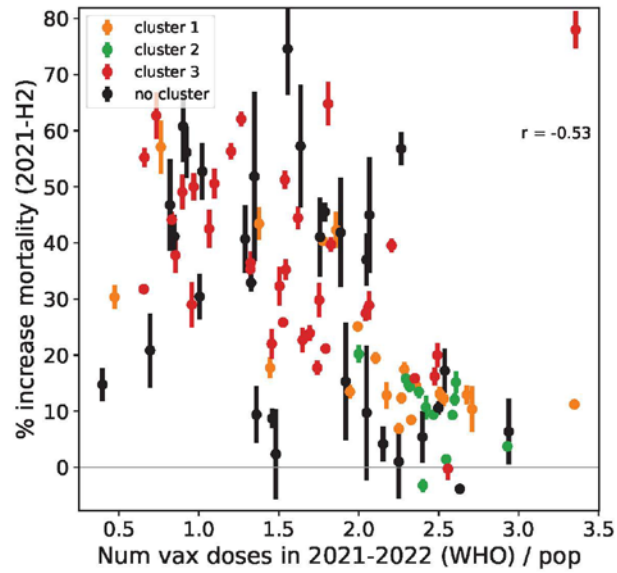
each case, the excess all-cause mortality is for the Covid period itself (2020-2022) and for each half year in the Covid period, 2020-H1 to 2023-H1.

Figure 42, Figure 43, and Figure 44 are for excess all-cause mortality expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same mortality period (“P-score”), whereas Figure 45, Figure 46, and Figure 47 are for excess all-cause mortality expressed as a fraction of 2019 population.

A table of the corresponding Pearson correlation coefficients is in **Appendix I**.







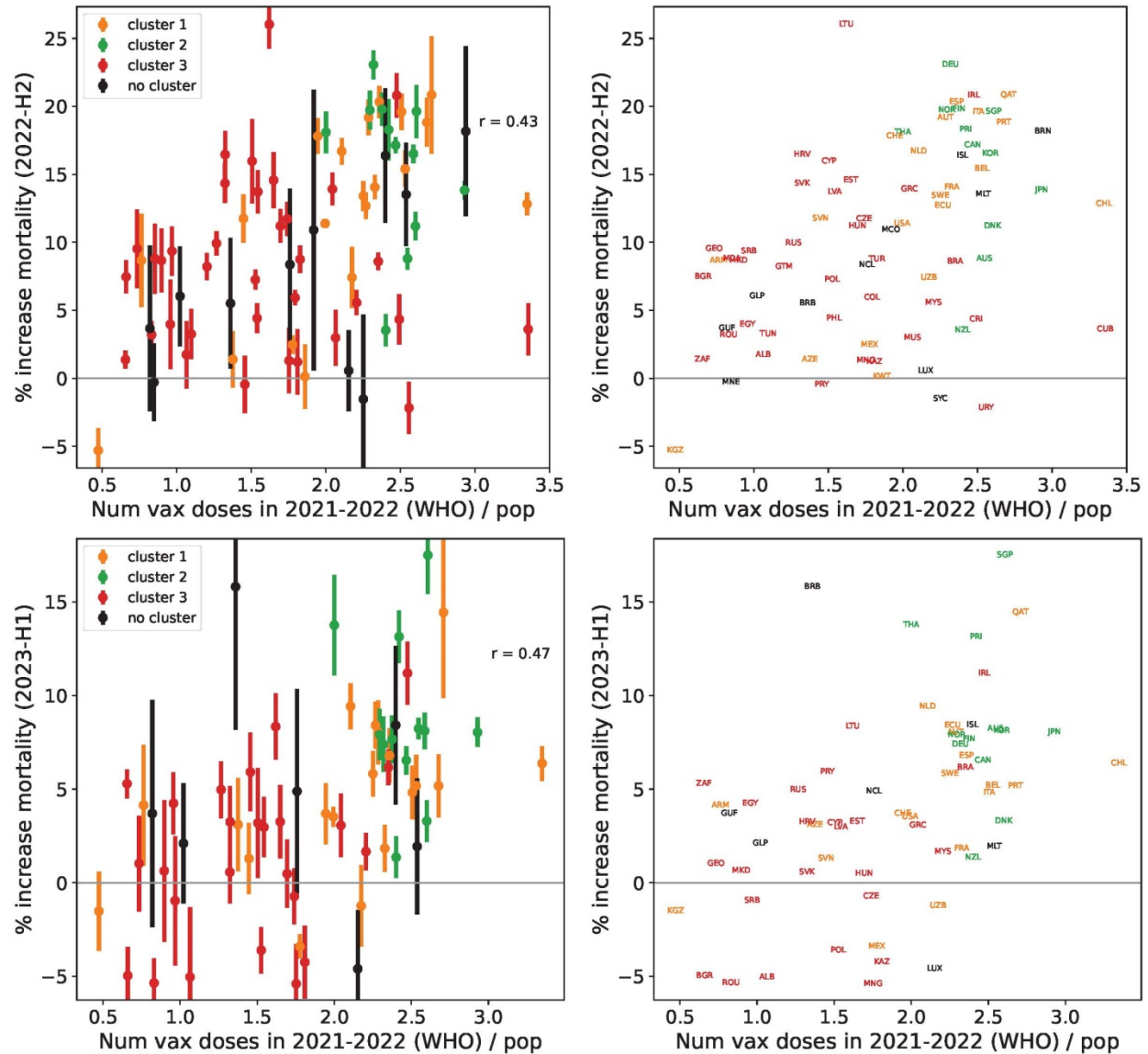
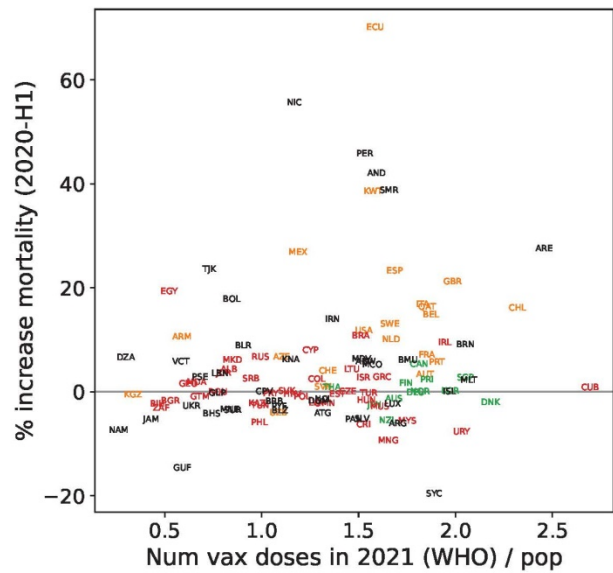
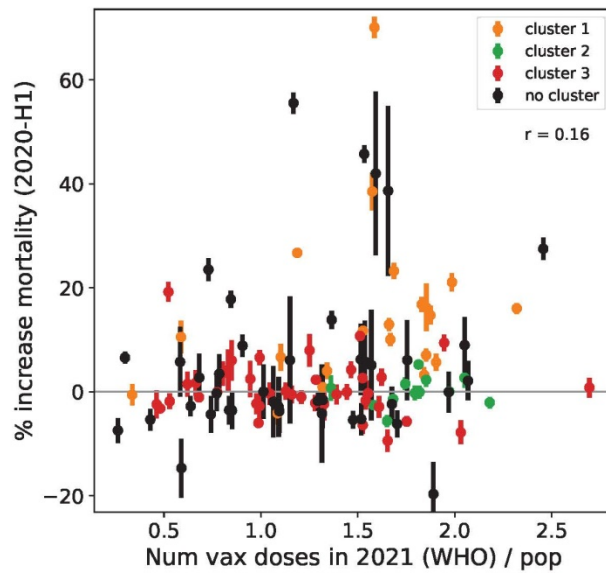
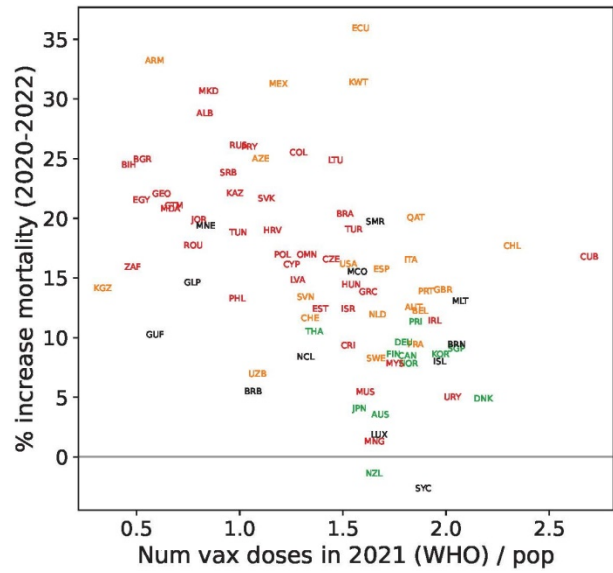
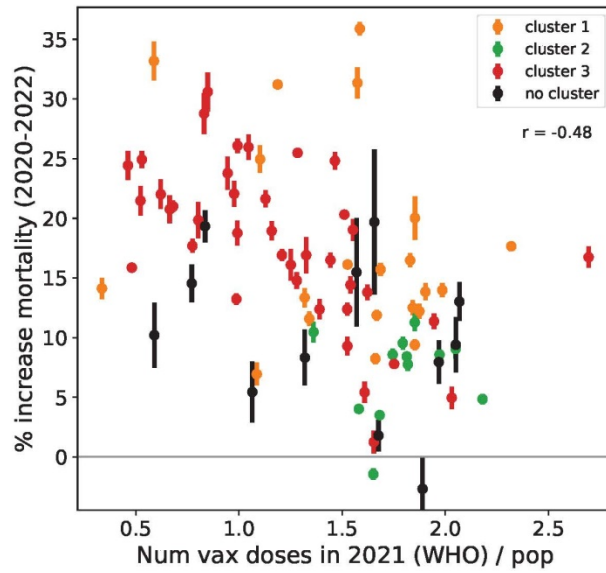
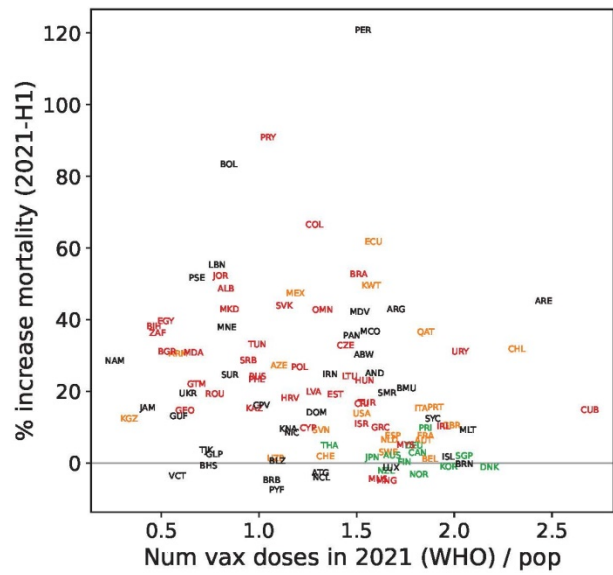
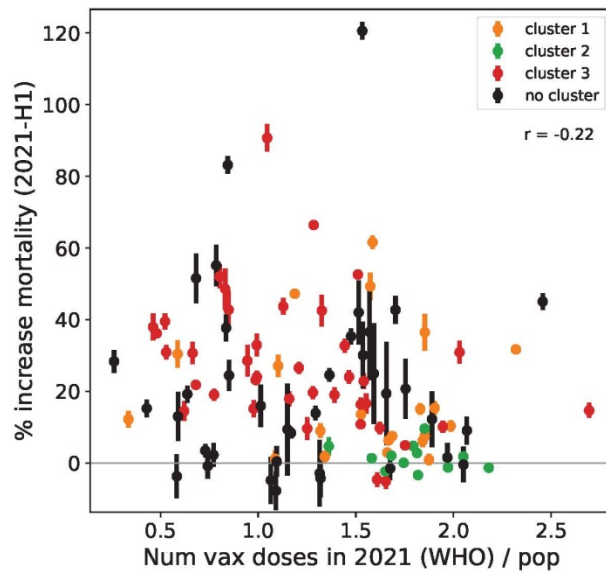
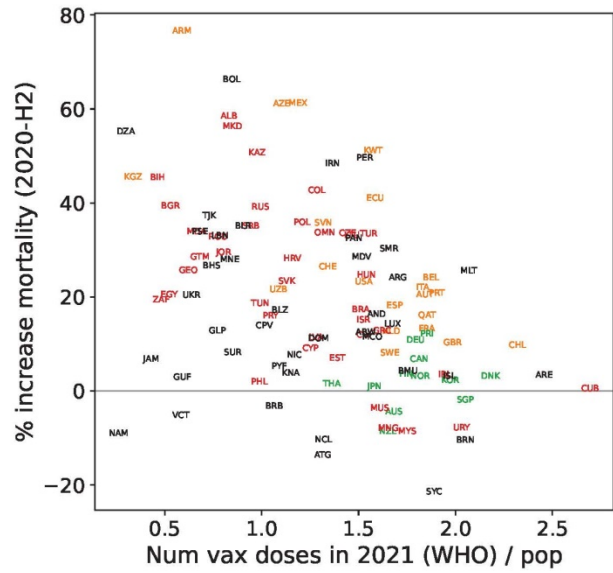
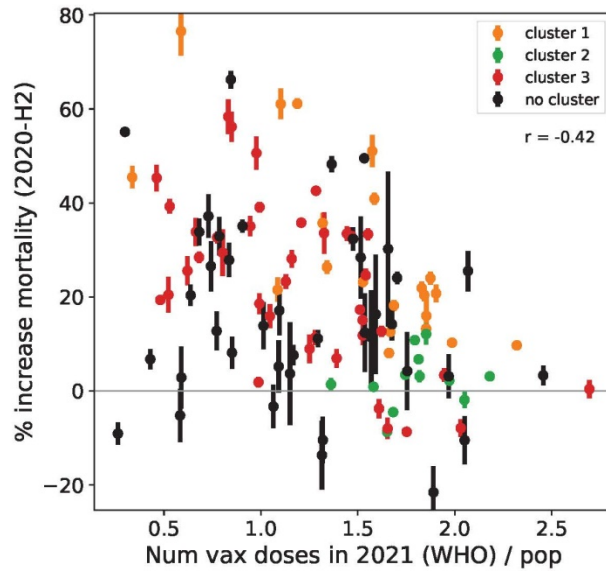
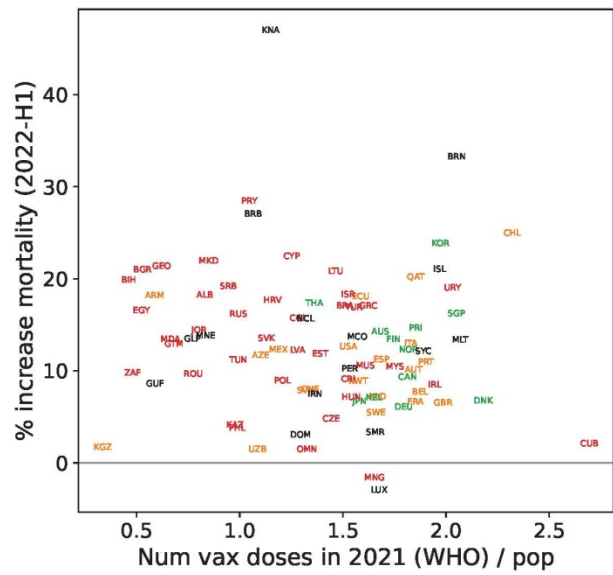
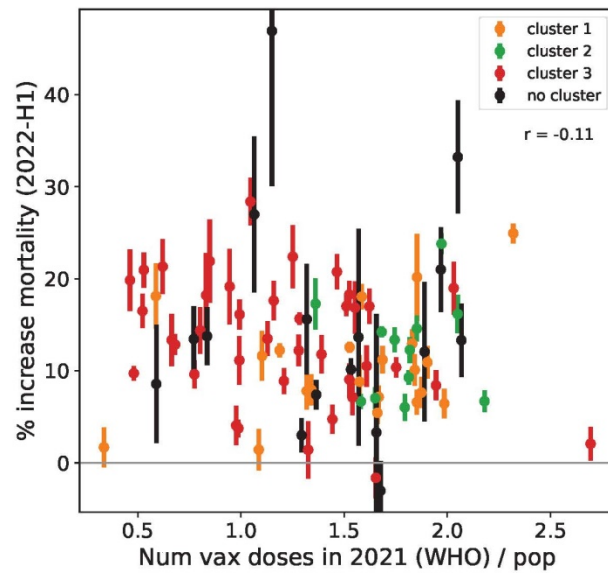
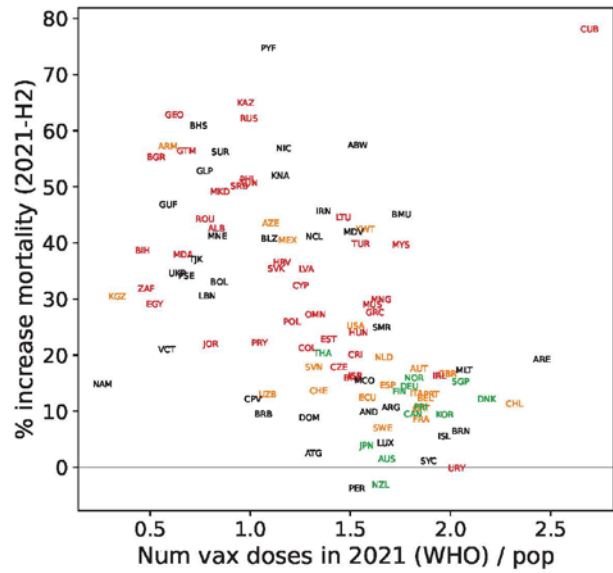
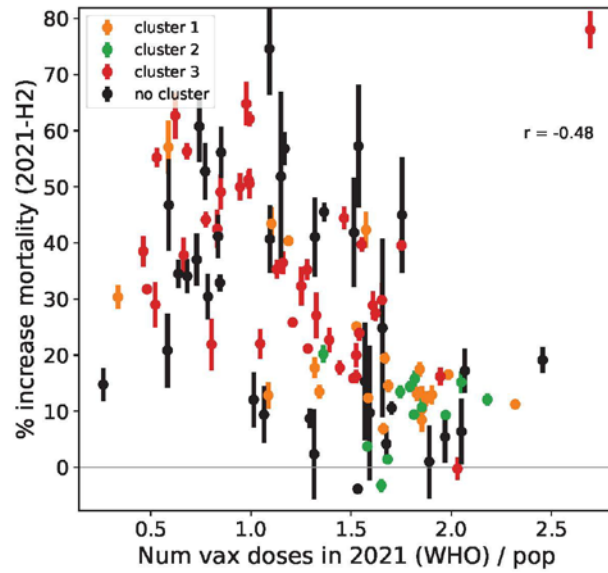


Figure 42. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus number of vaccine injections by 2019 population for the vaccination period 2021-2022 (WHO data), with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.







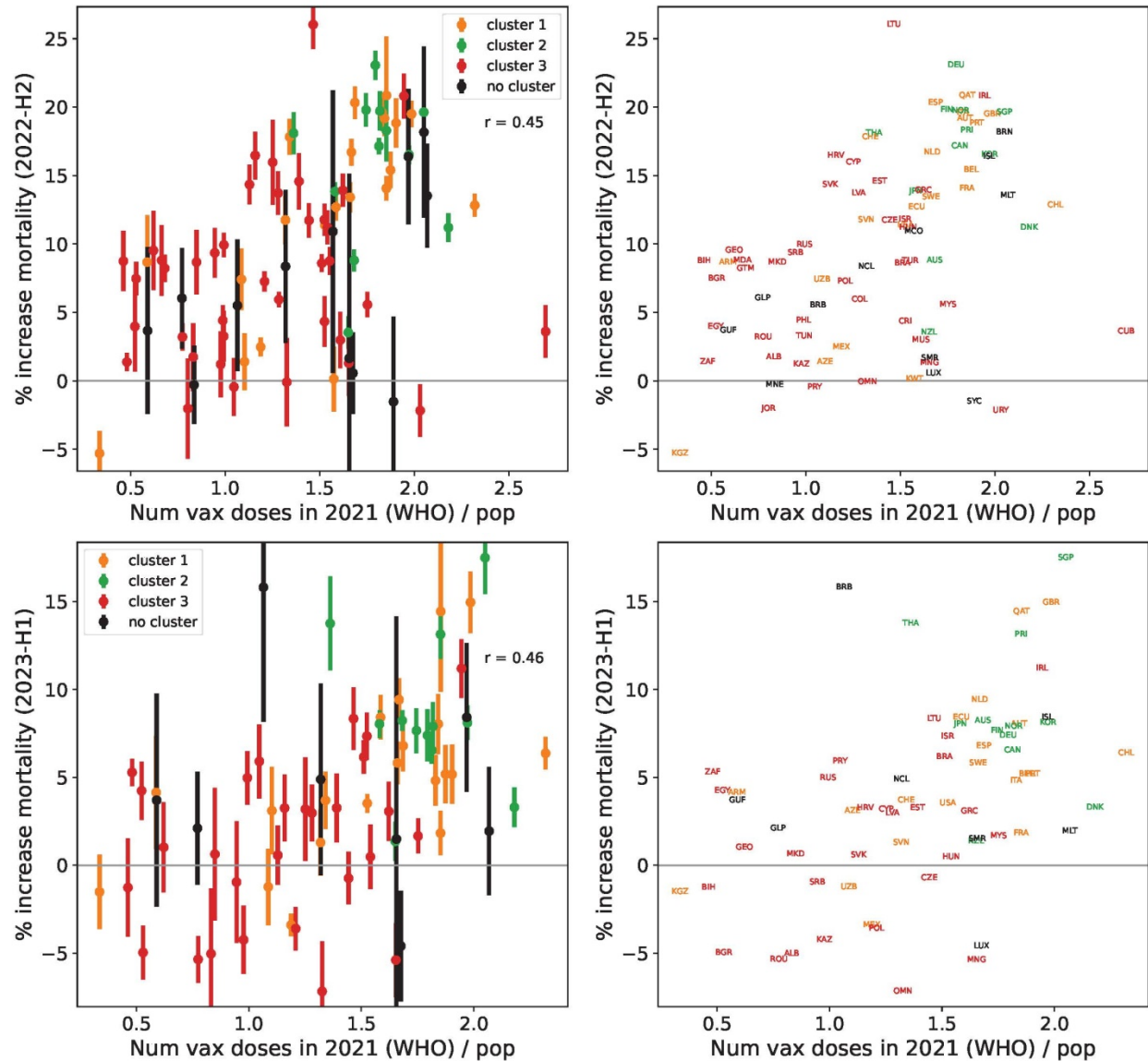
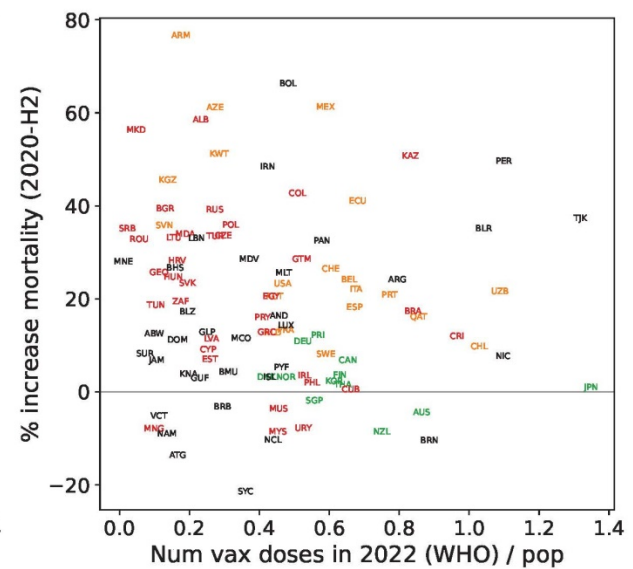
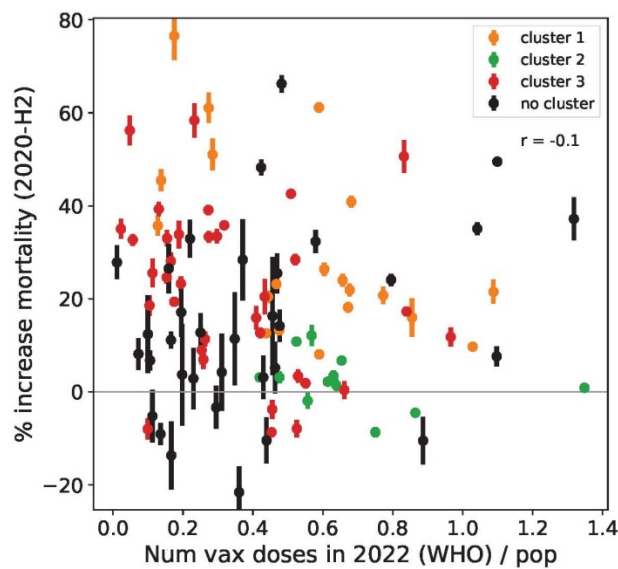
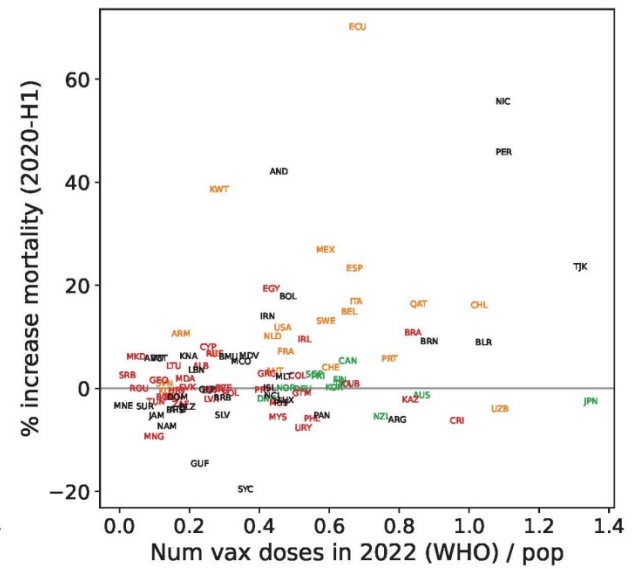
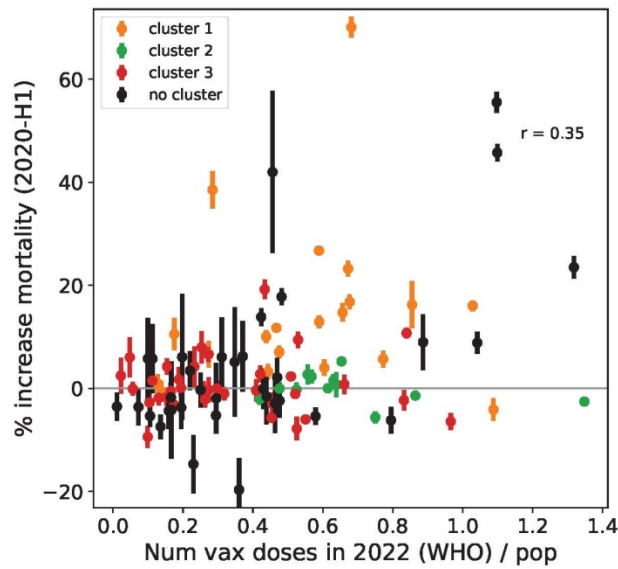
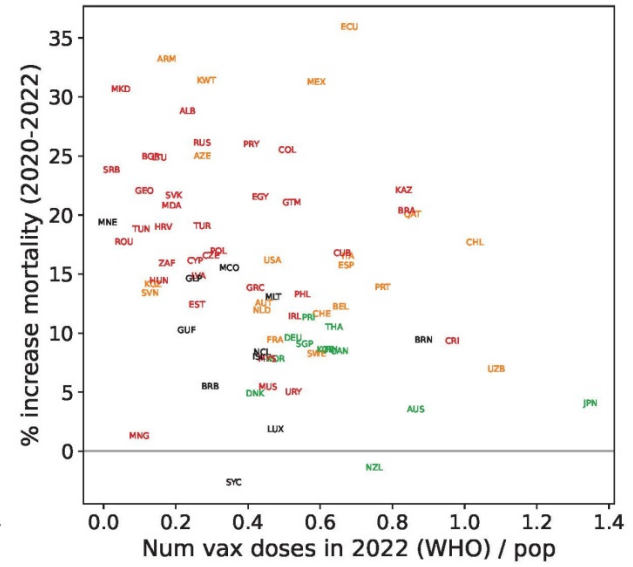
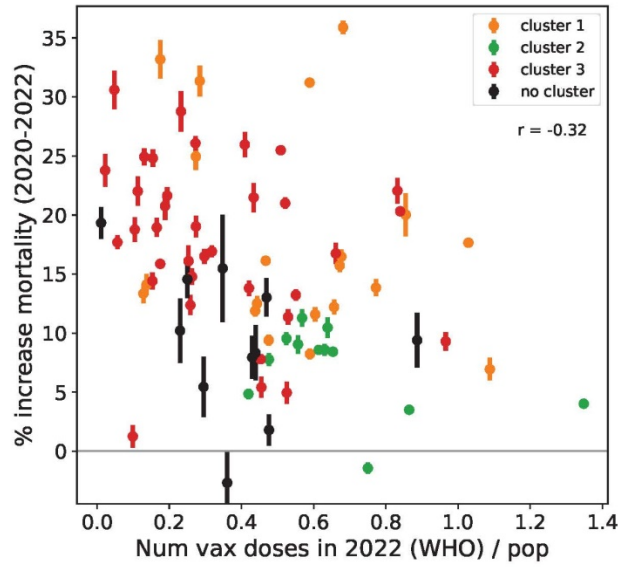
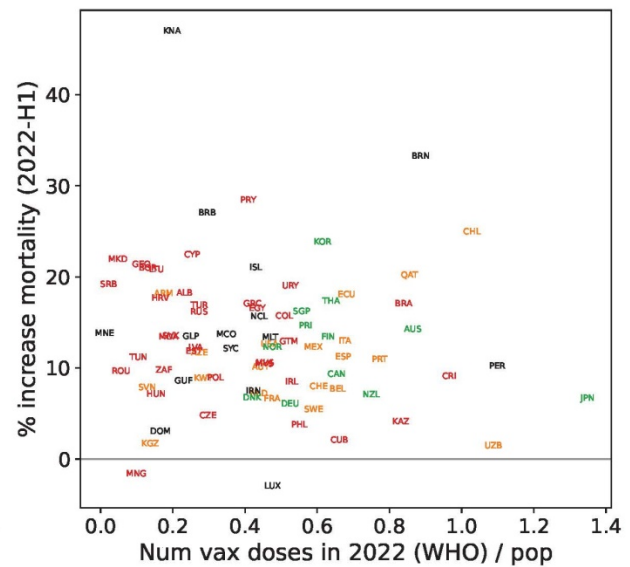
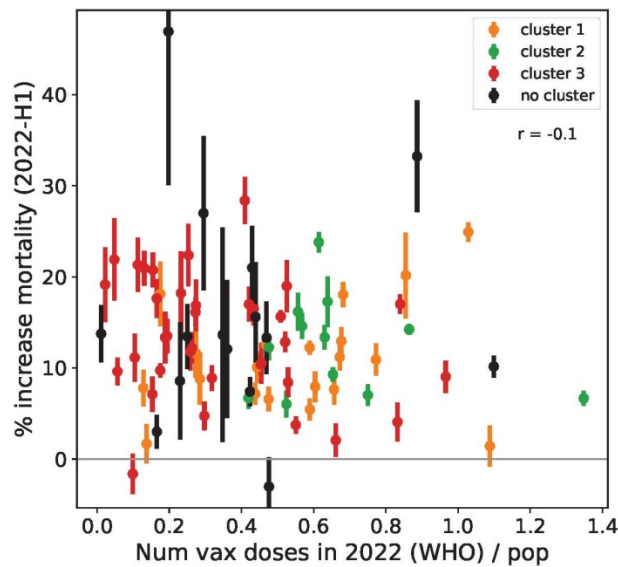
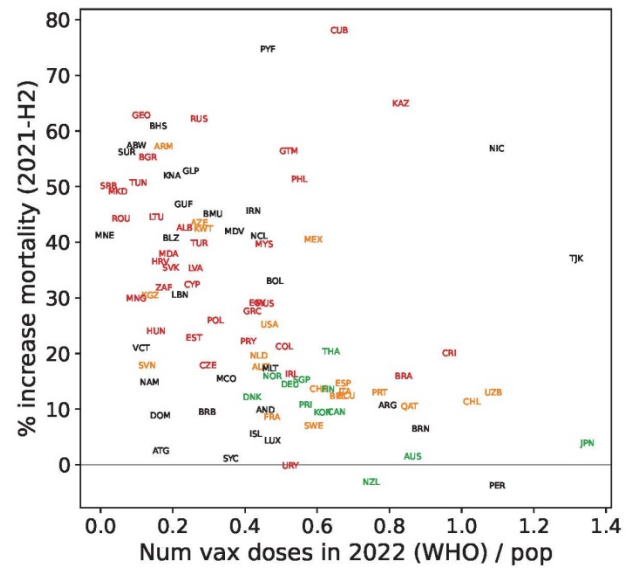
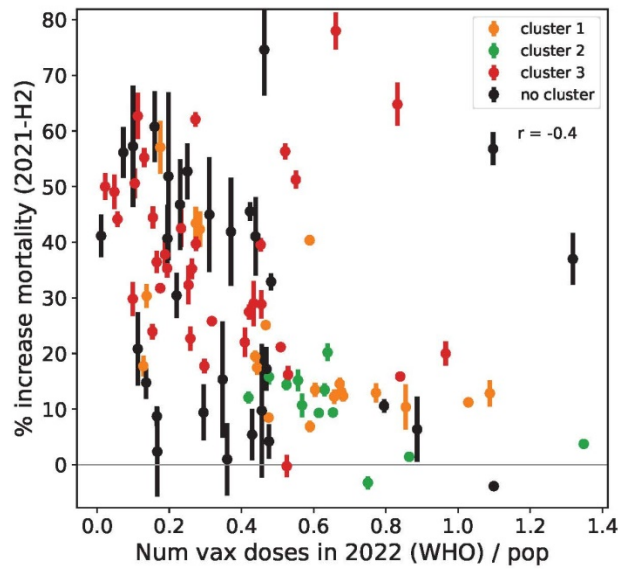
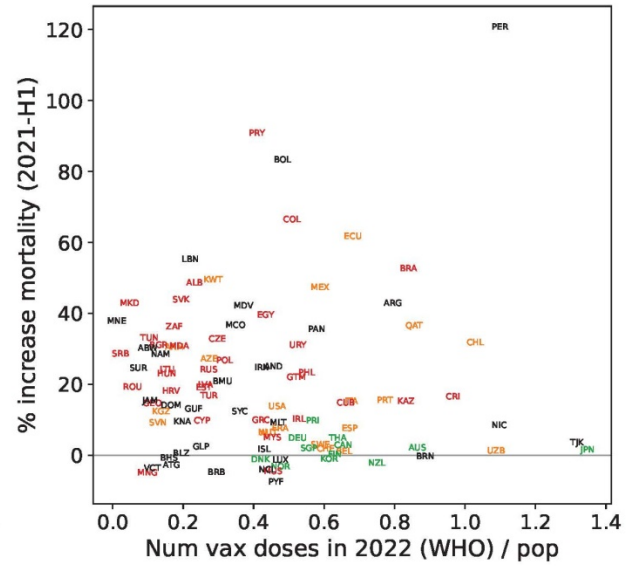
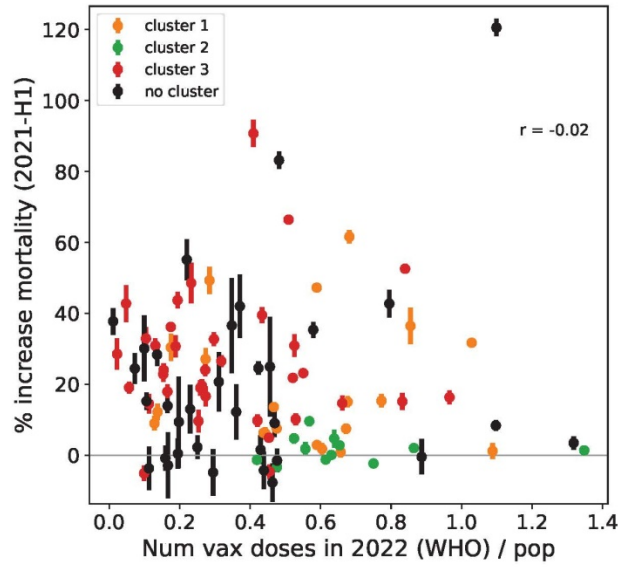


Figure 43. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period (“P-score”), versus number of vaccine injections by 2019 population for the vaccination period 2021 (WHO data), with 1 σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.





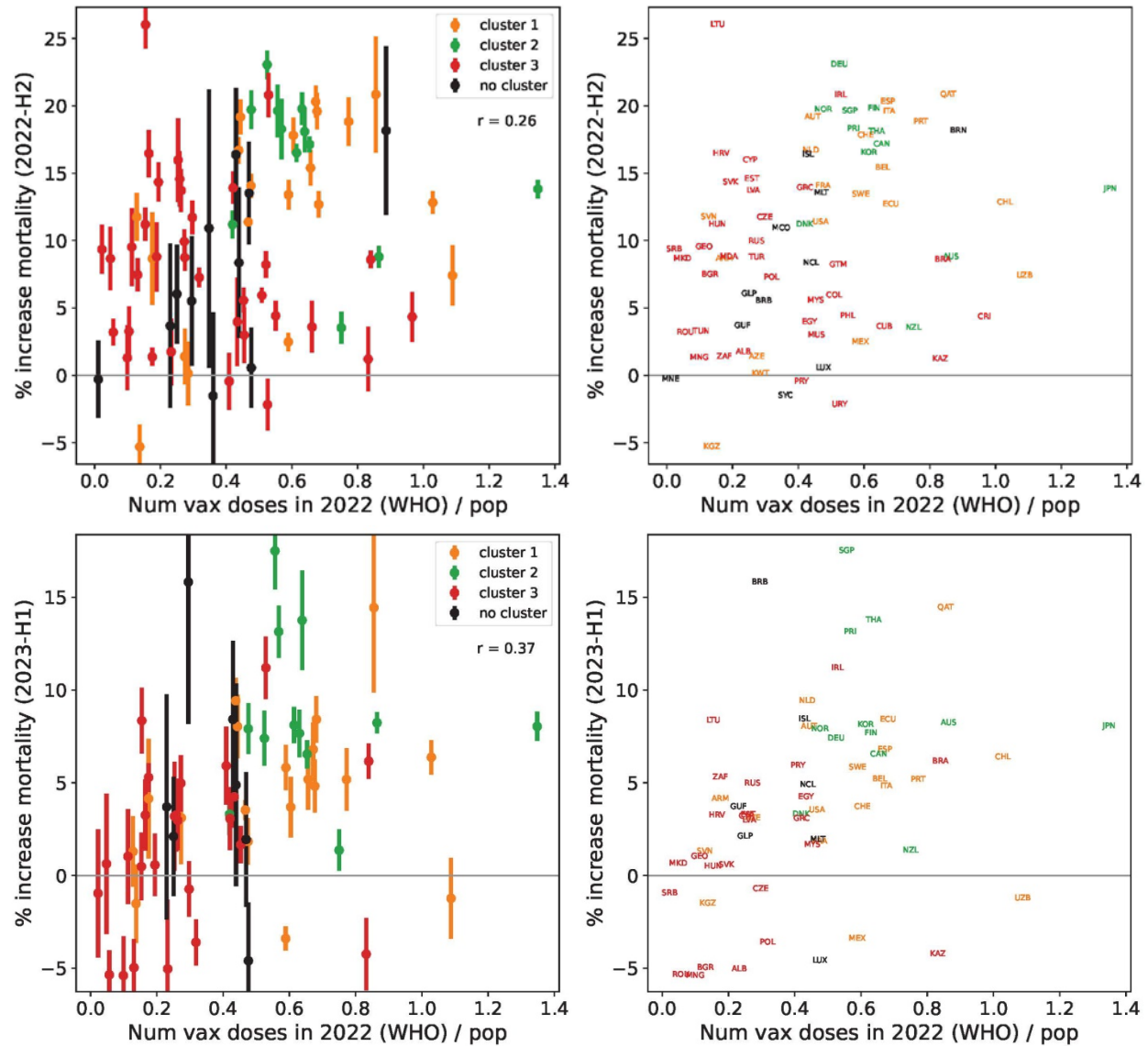
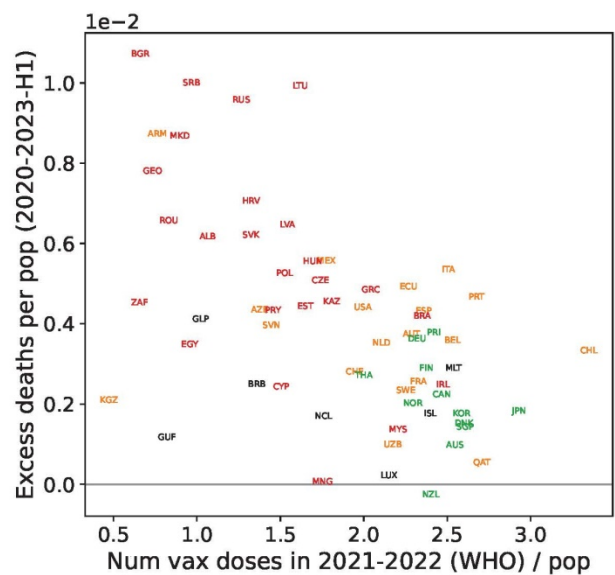
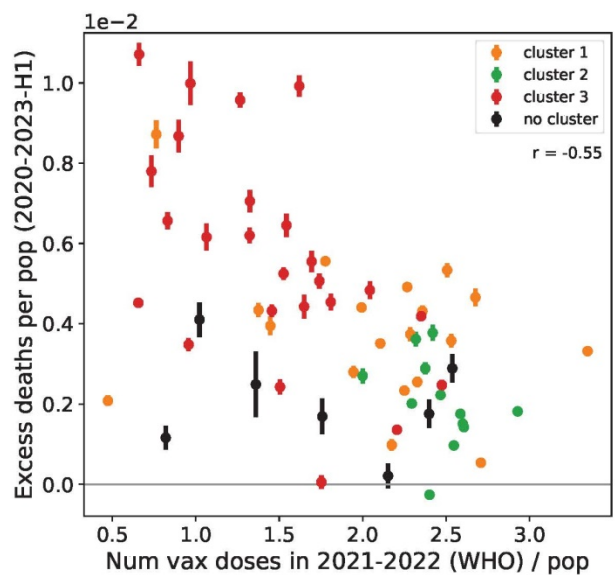
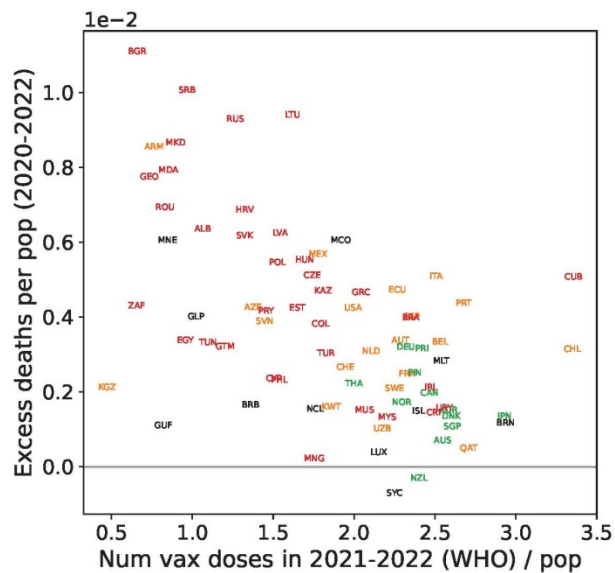
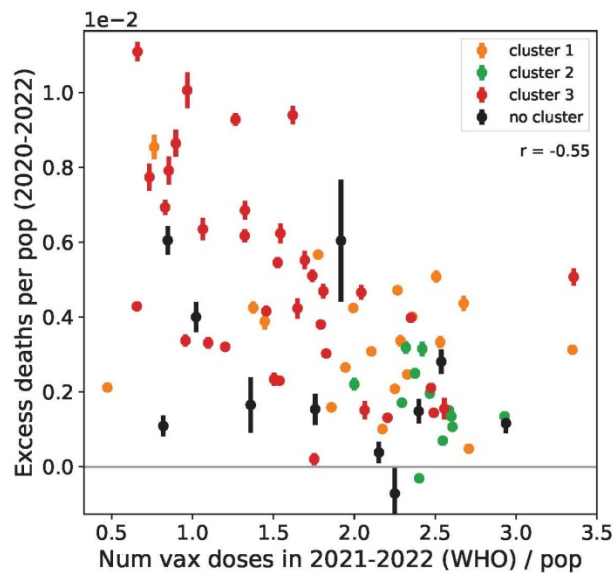
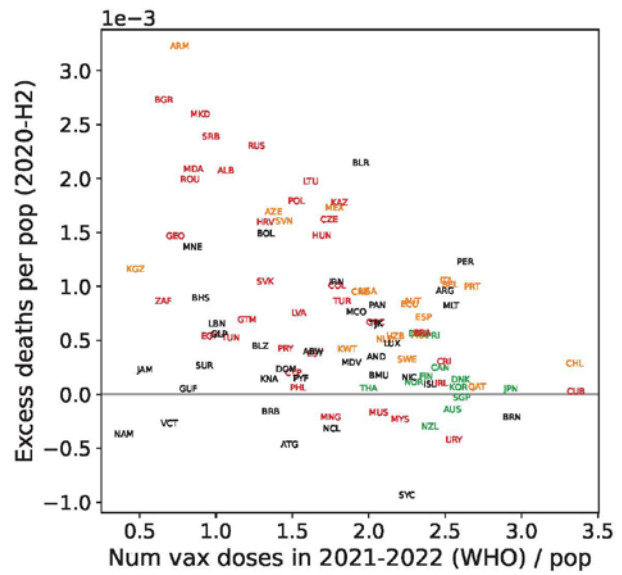
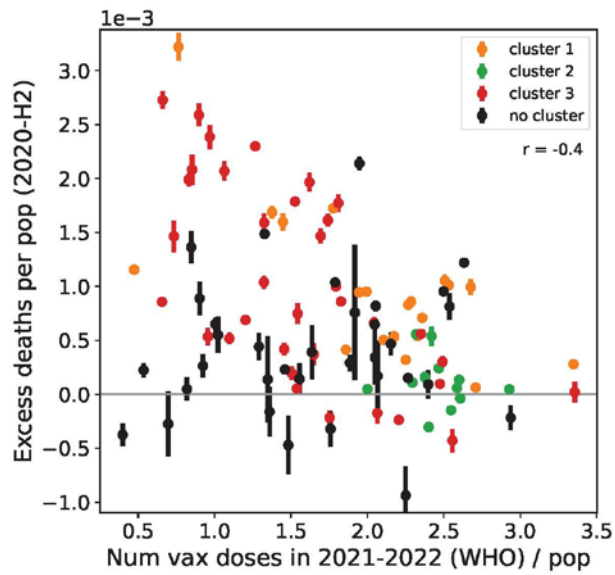
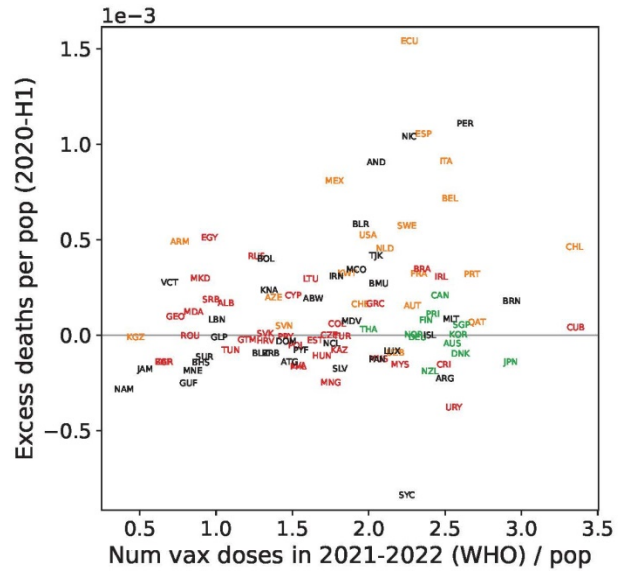
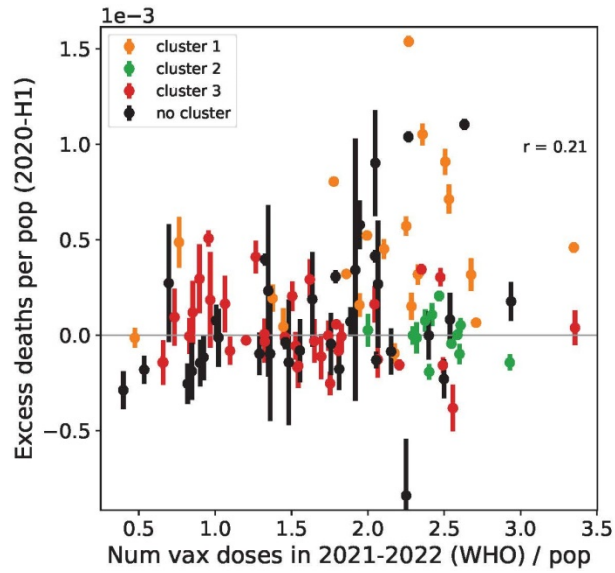
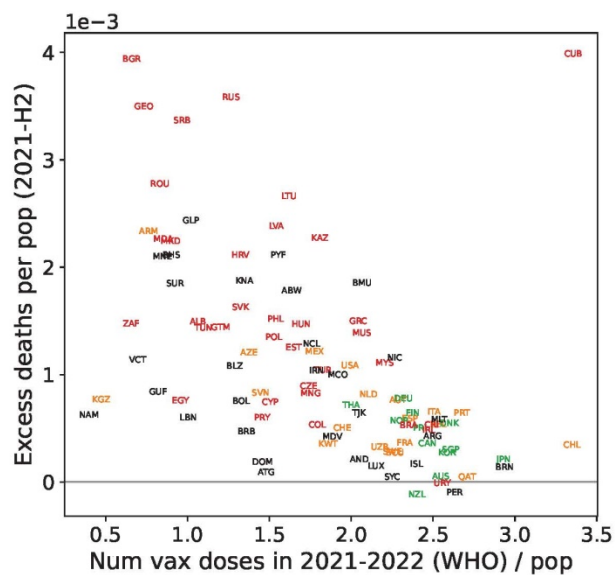
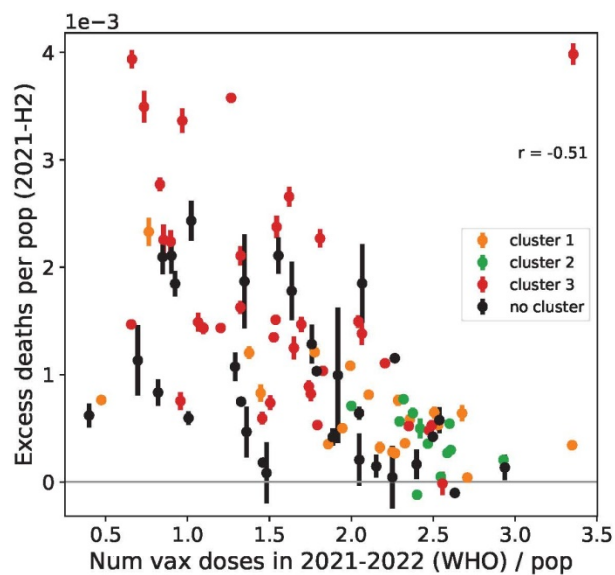
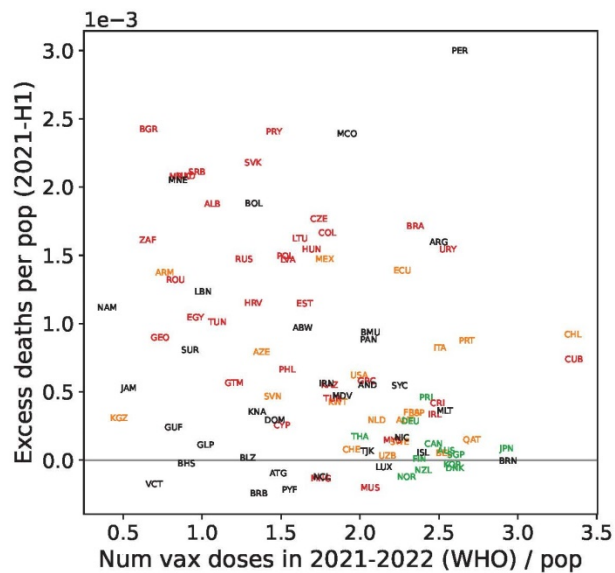
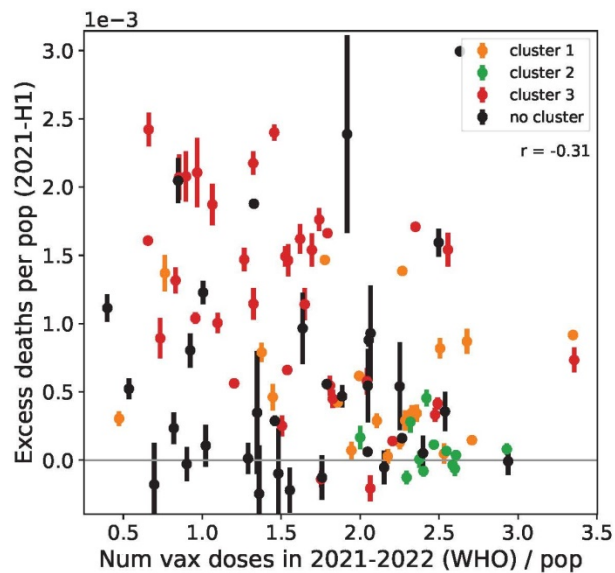
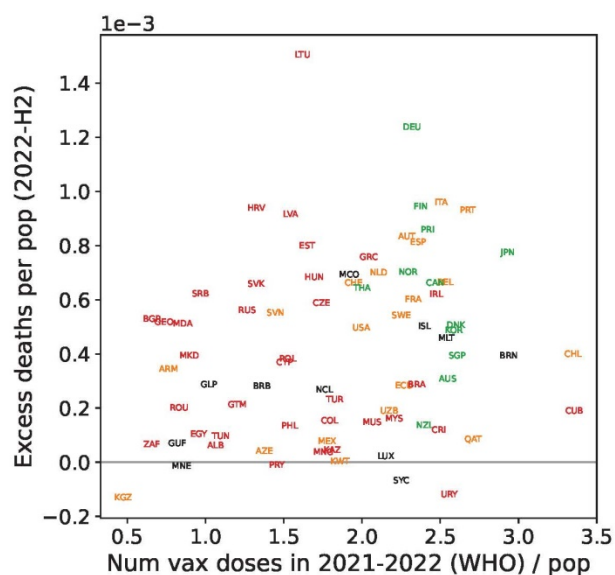
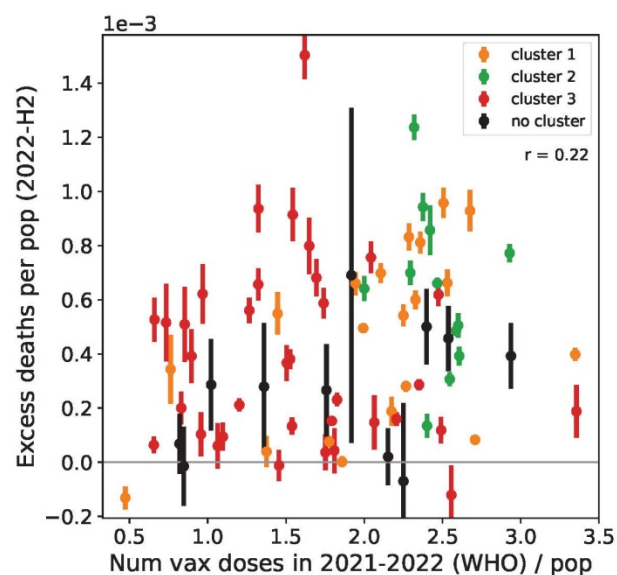
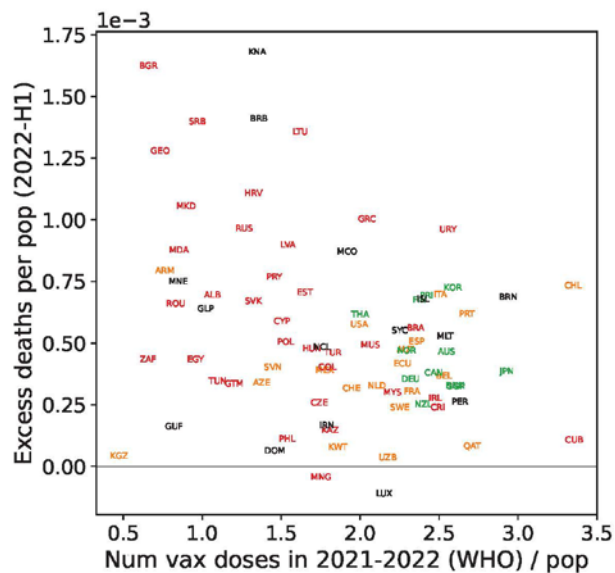
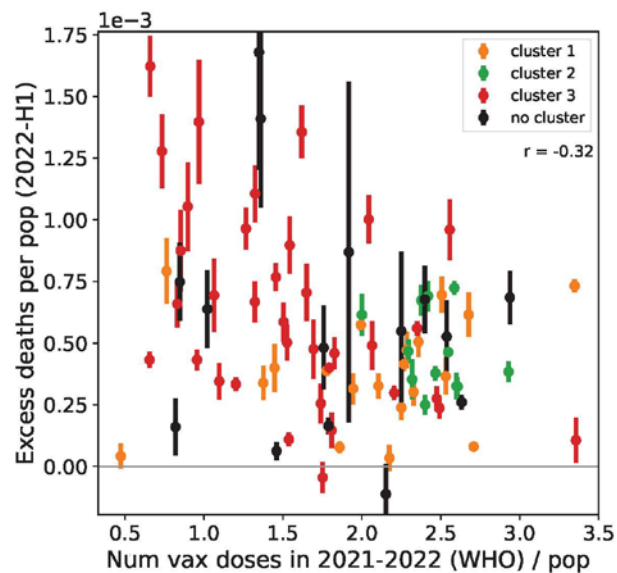


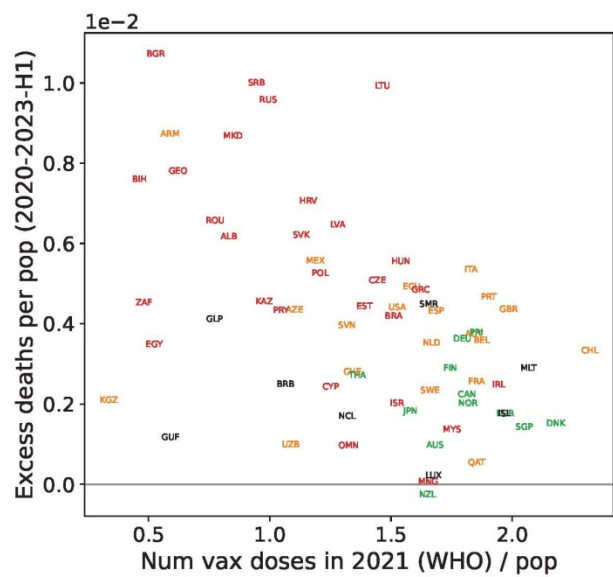
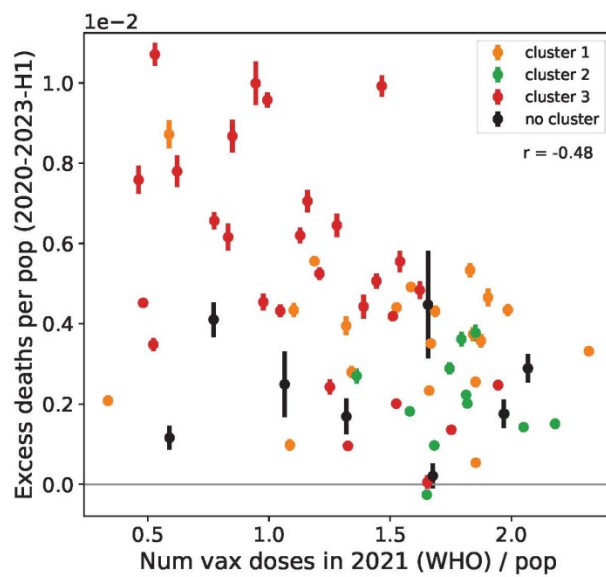
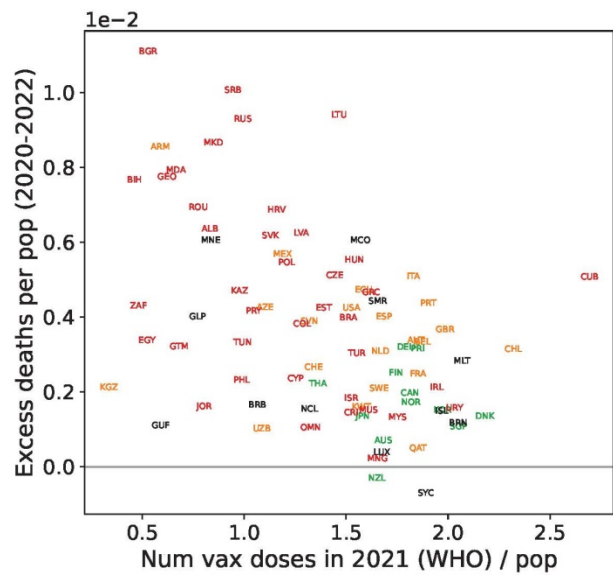
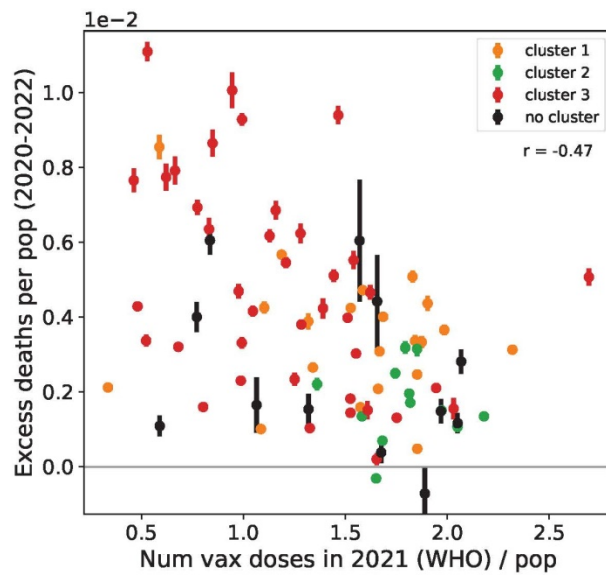
Figure 44. Excess all-cause mortality for the Covid period (2020-2022) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a percentage of the predicted (extrapolated historic trend, see Methods) mortality for the same period ("P-score"), versus number of vaccine injections by 2019 population for the vaccination period 2022 (WHO data), with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.

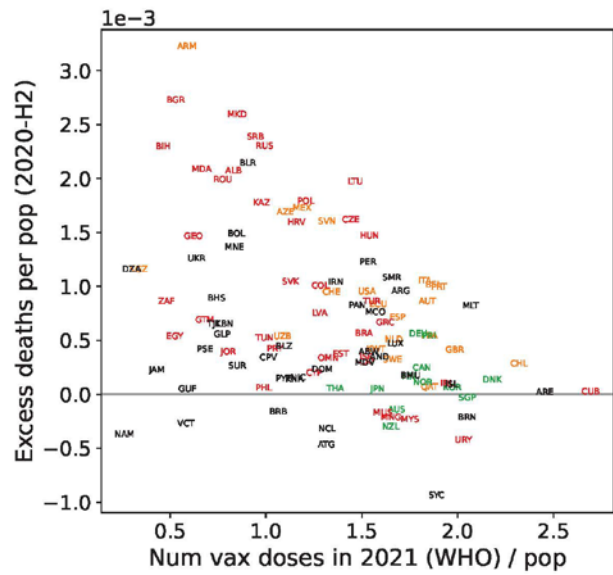
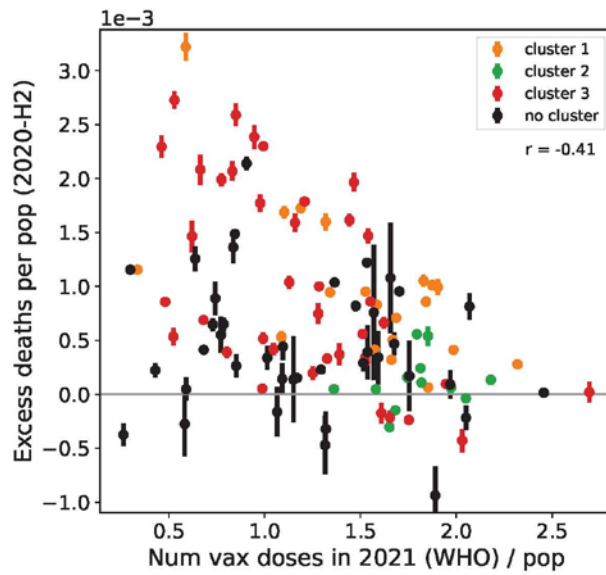
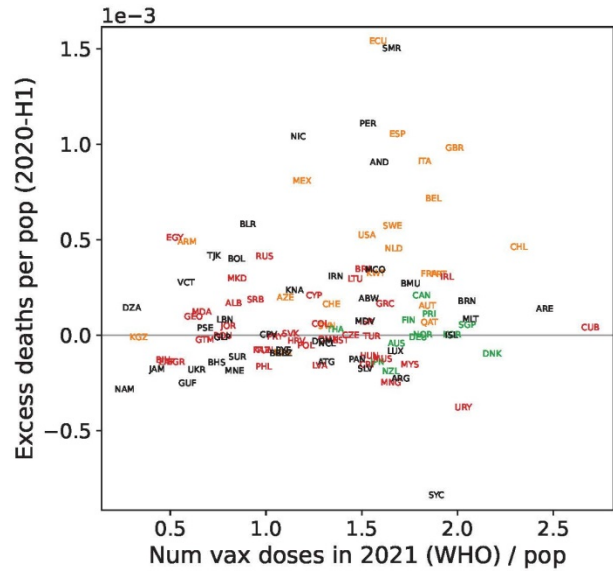
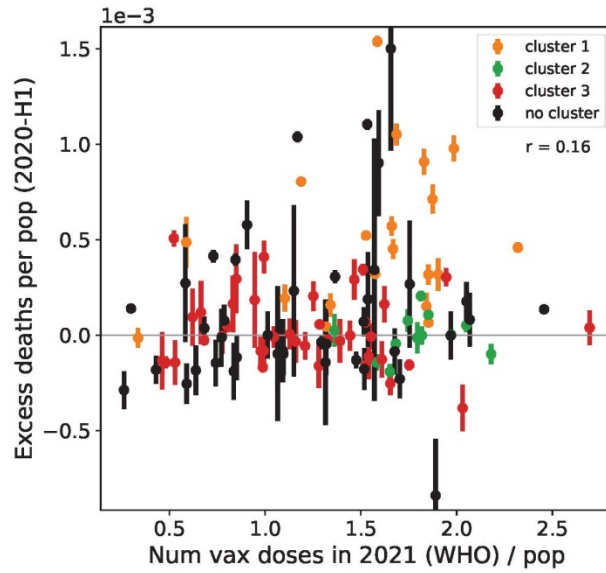


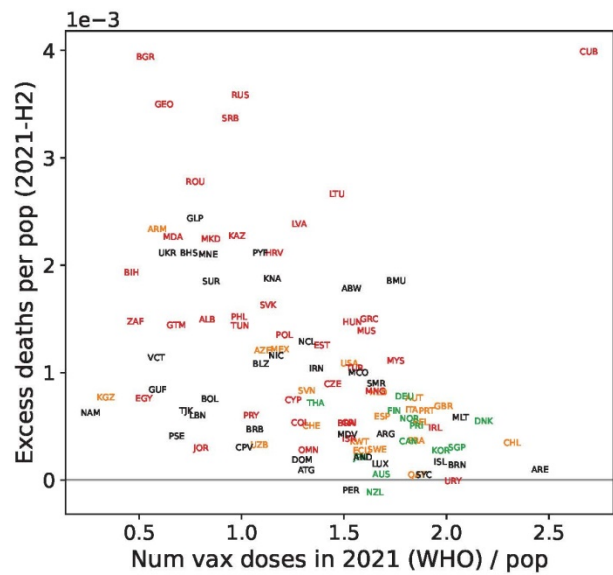
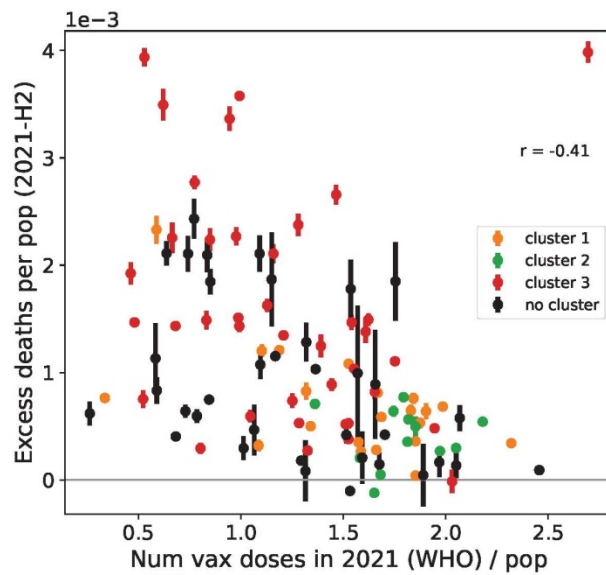
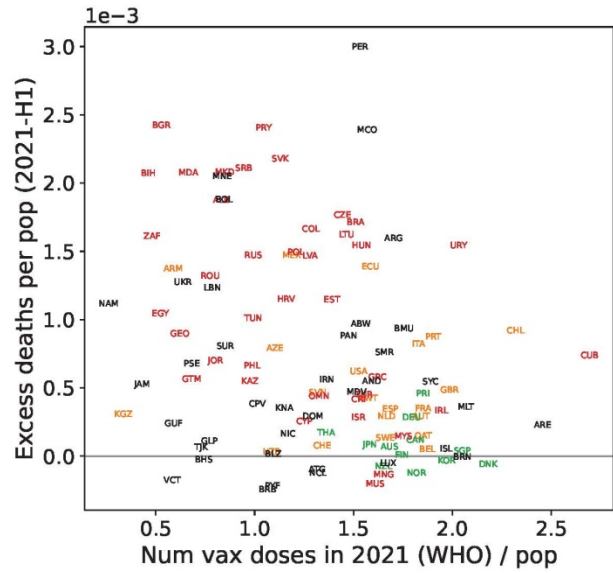
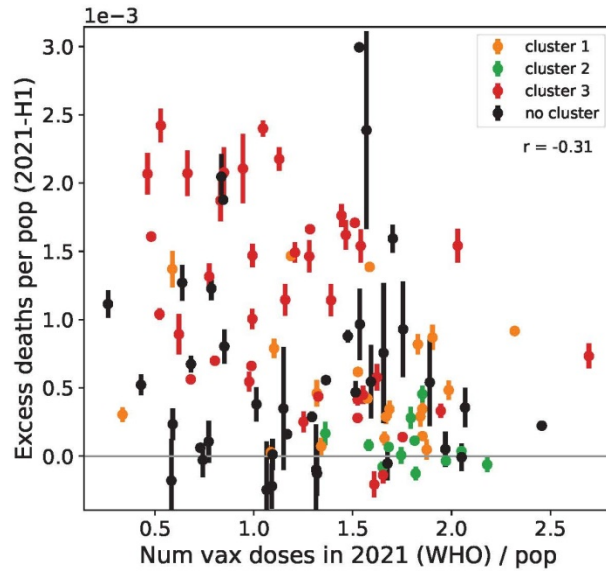


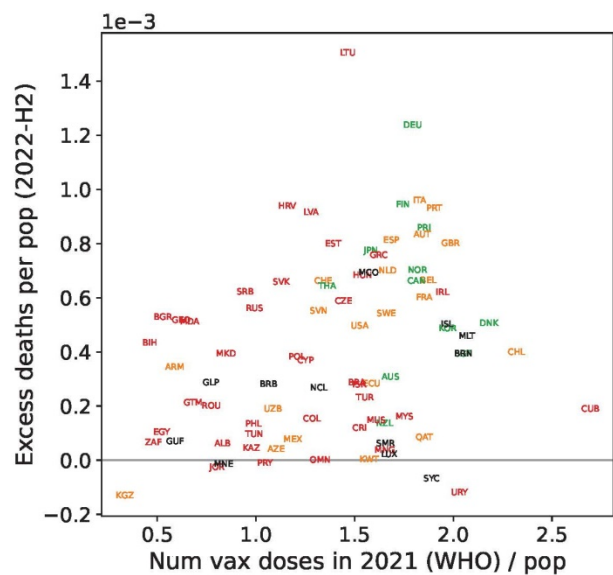
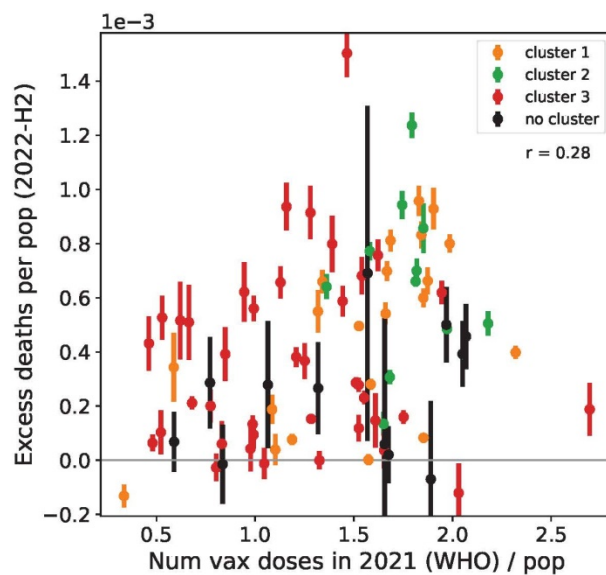
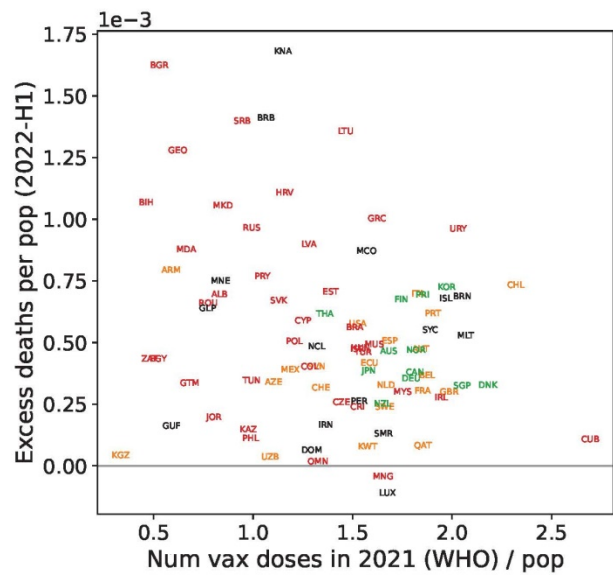
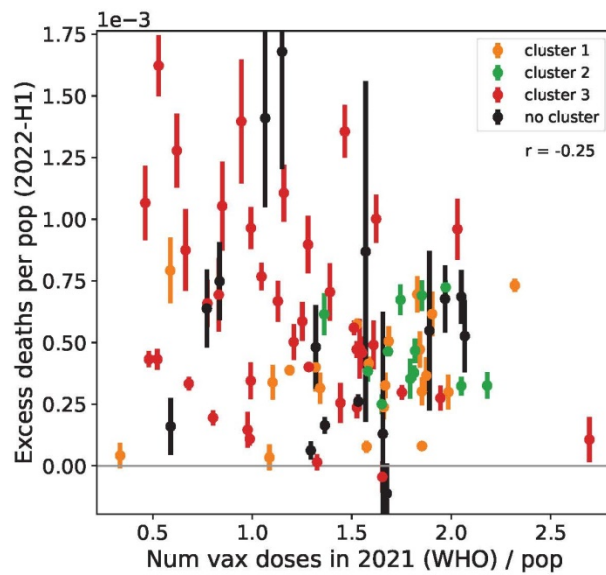












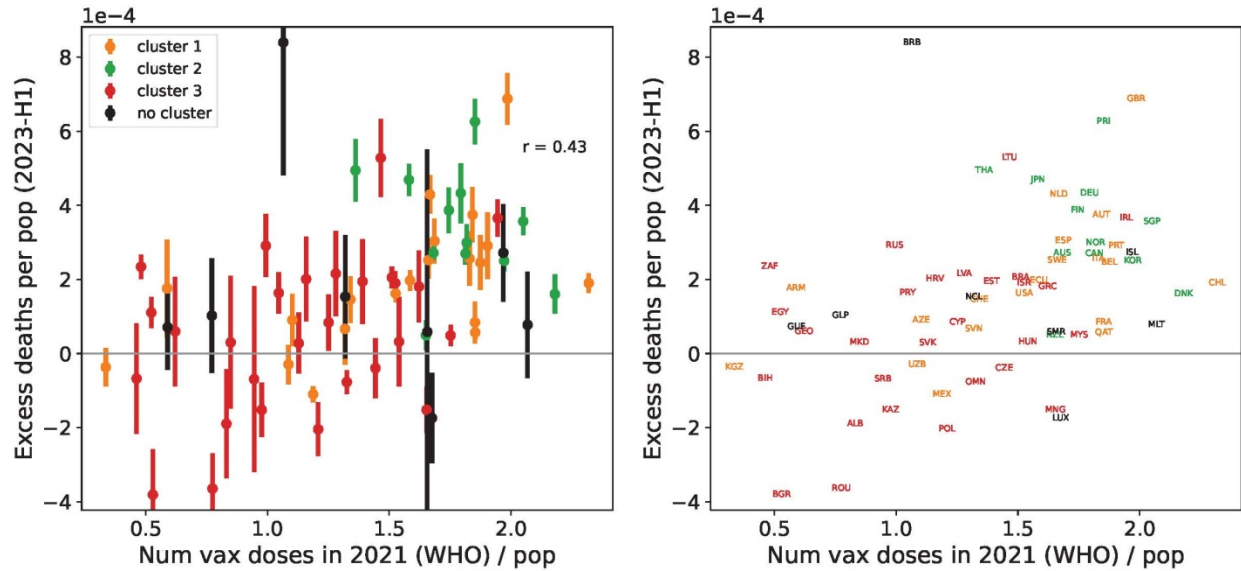
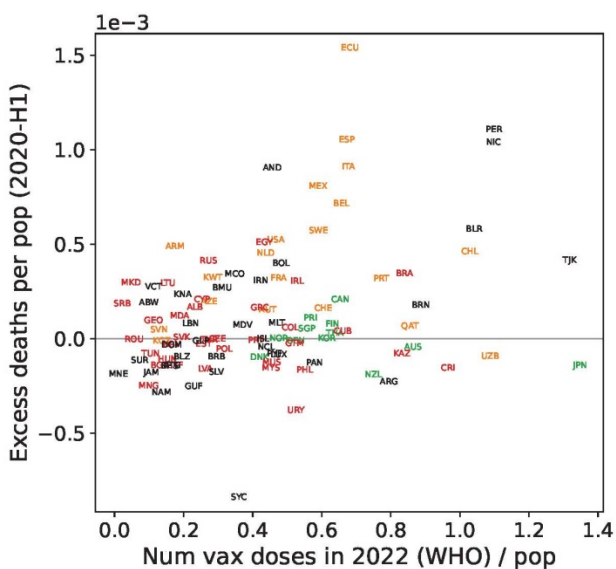
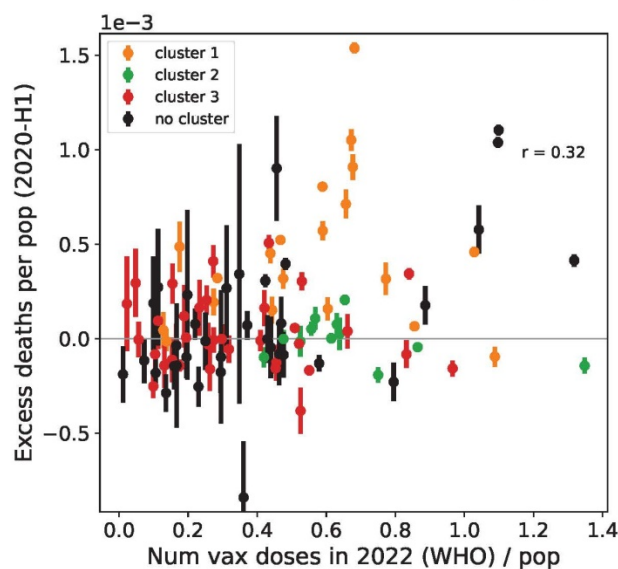
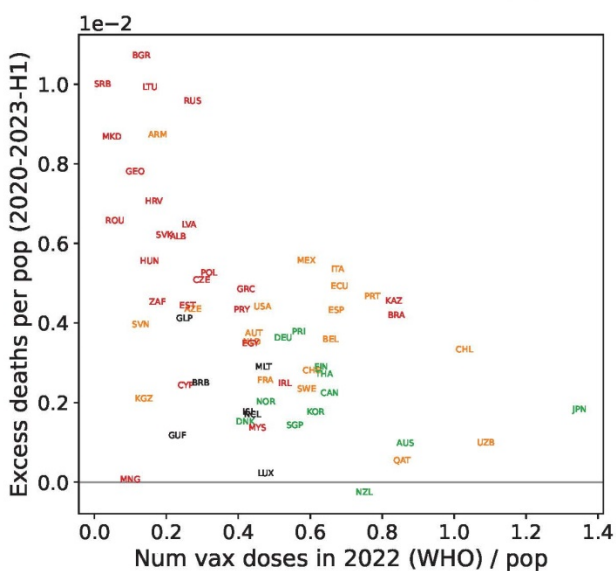
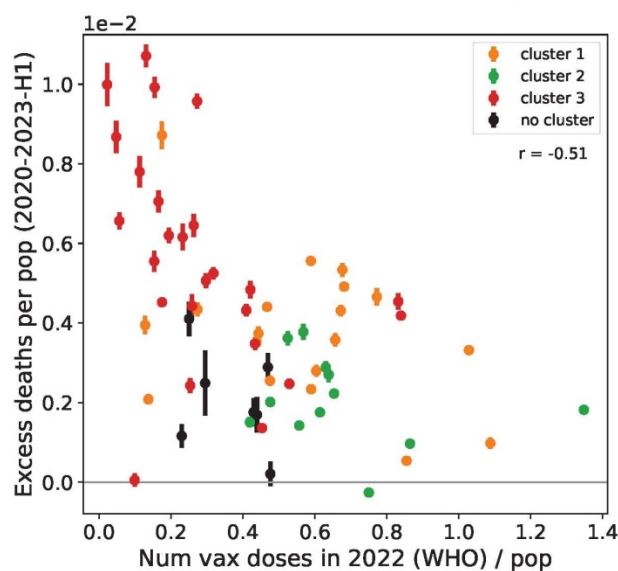
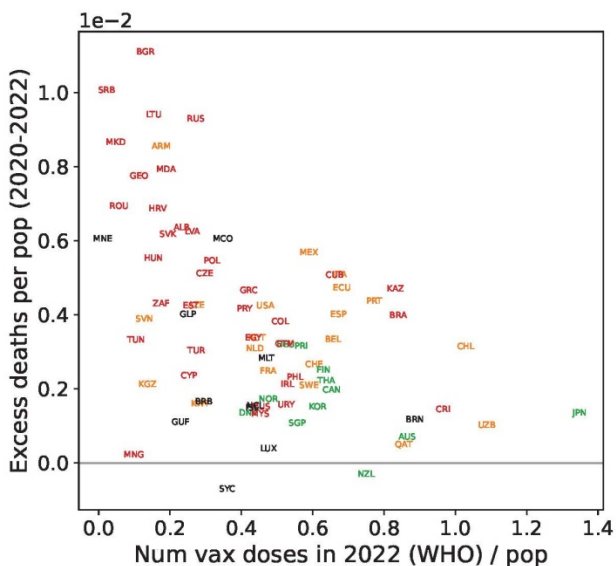
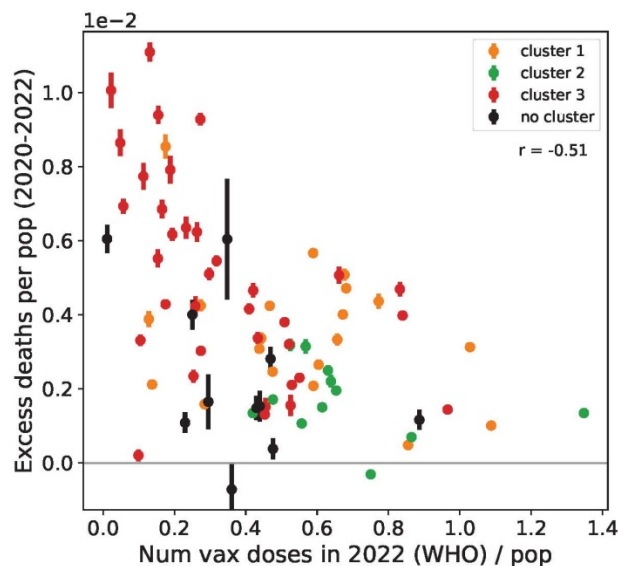
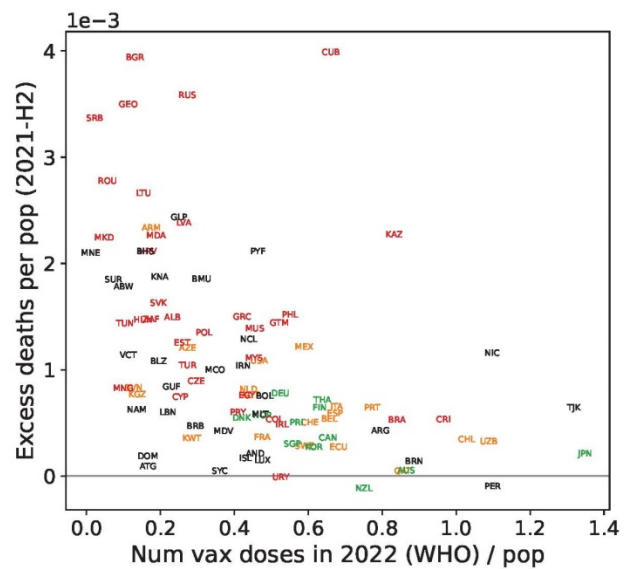
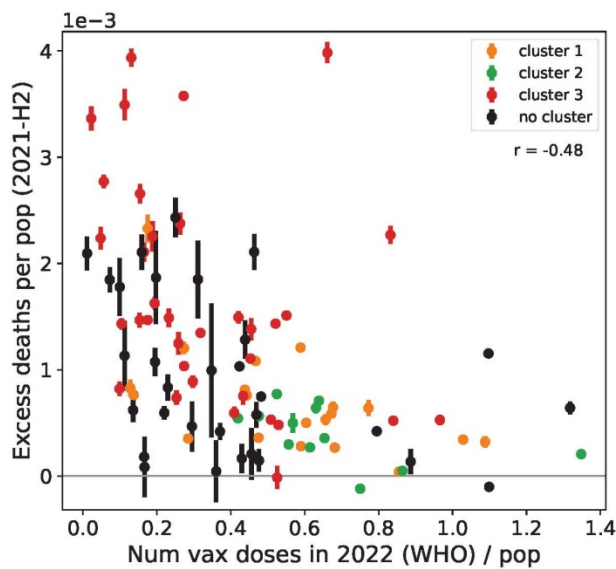
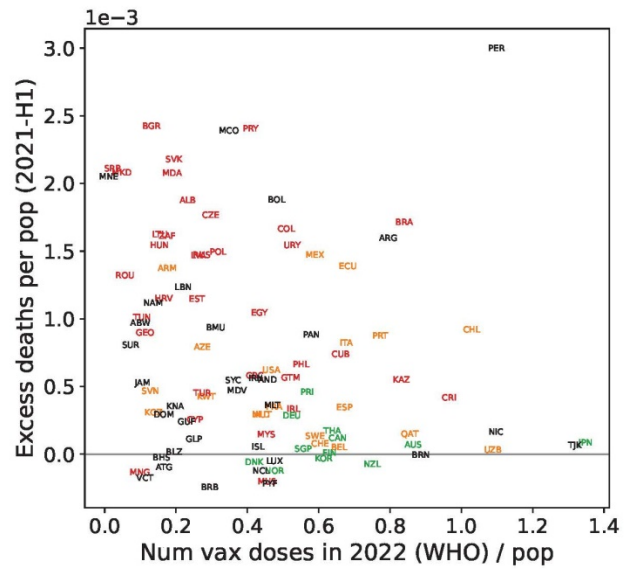
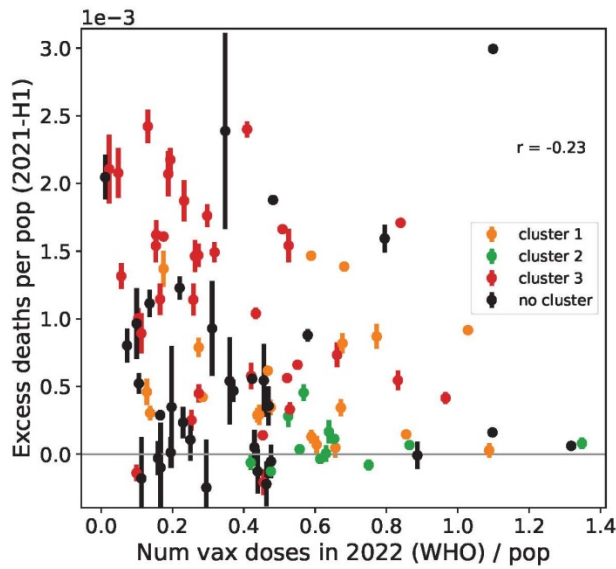
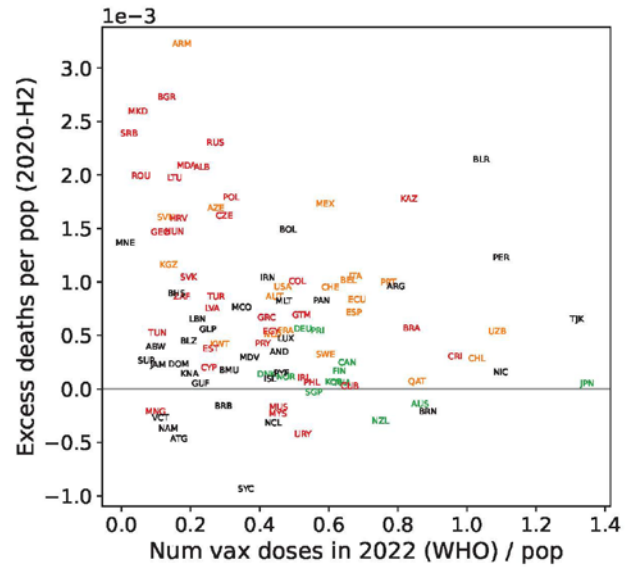
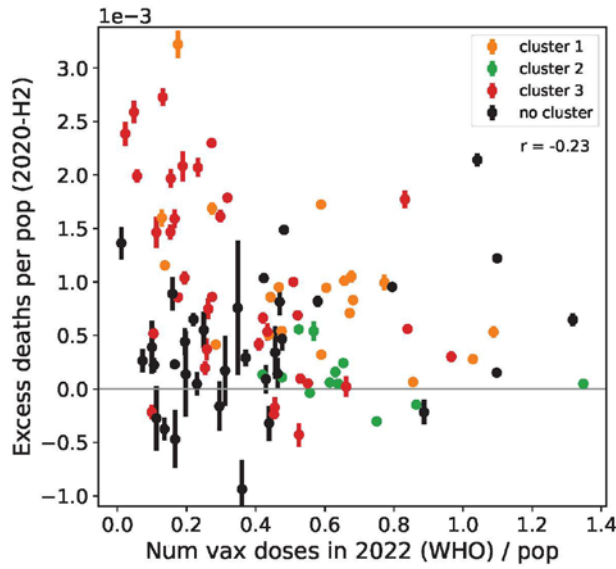


Figure 46. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus number of vaccine injections by 2019 population for the vaccination period 2021 (WHO data), with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.





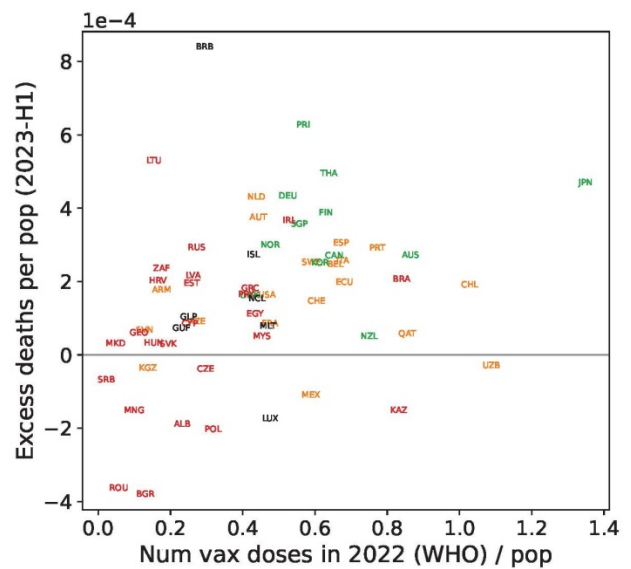
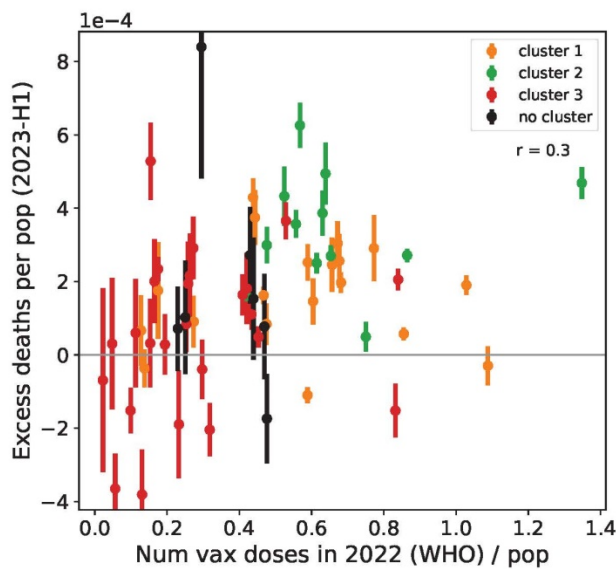
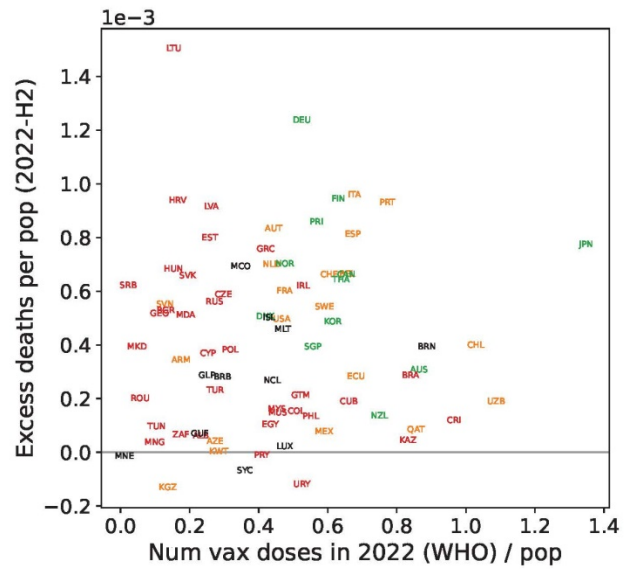
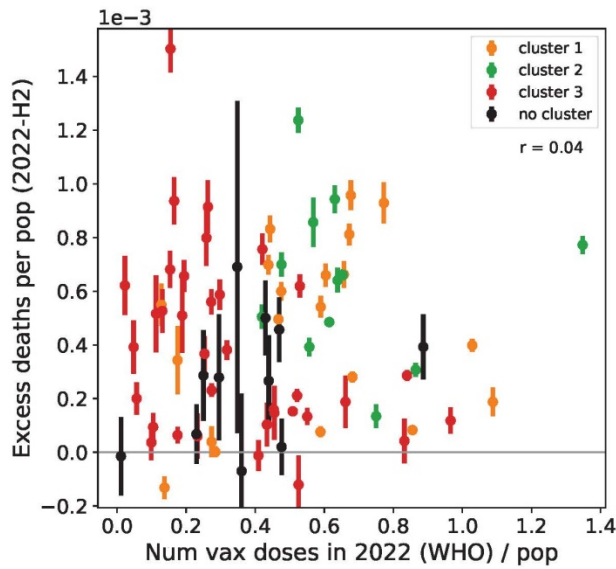
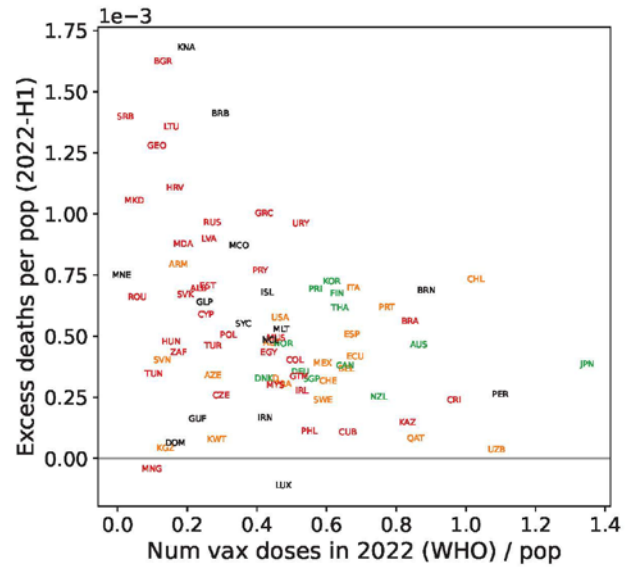
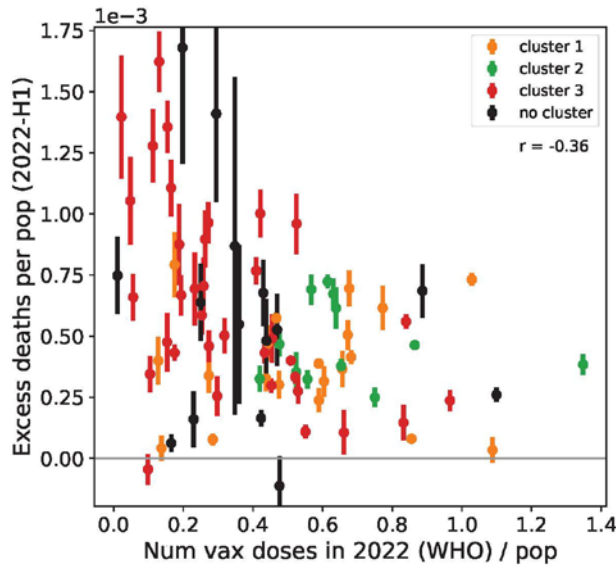
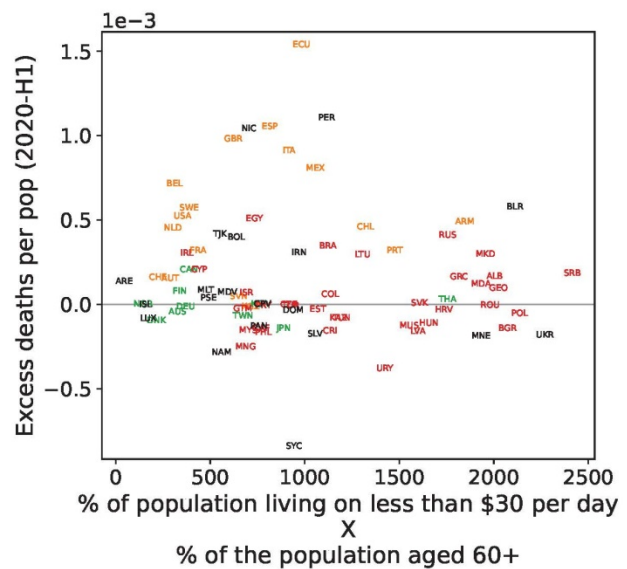
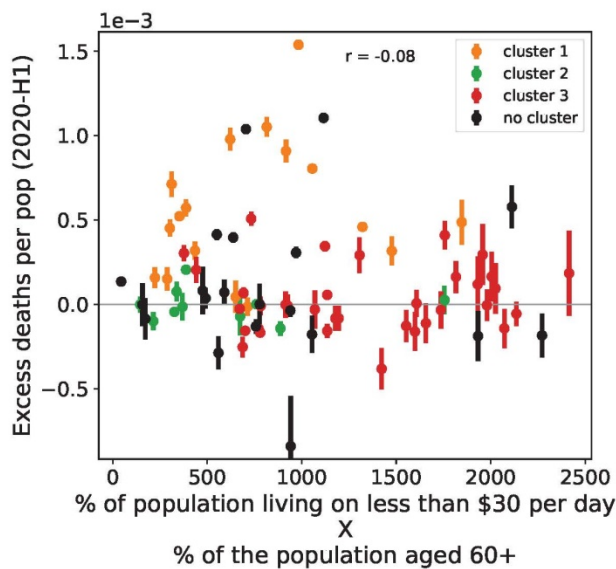
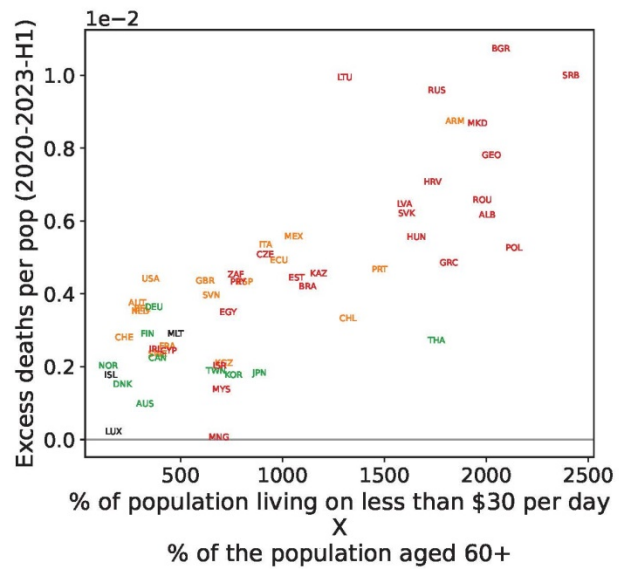
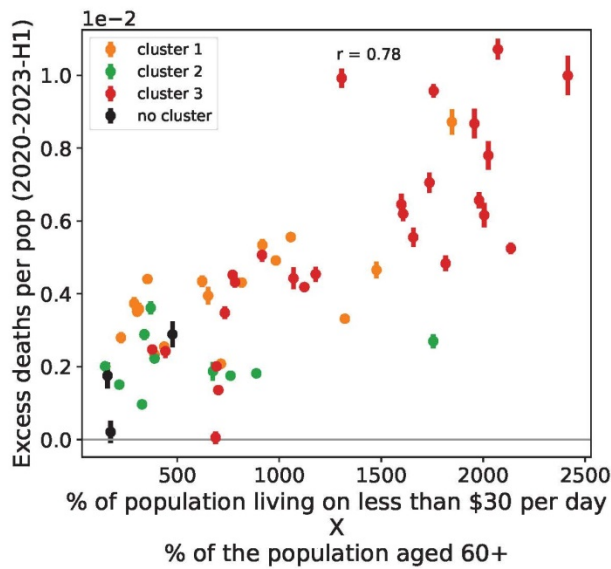
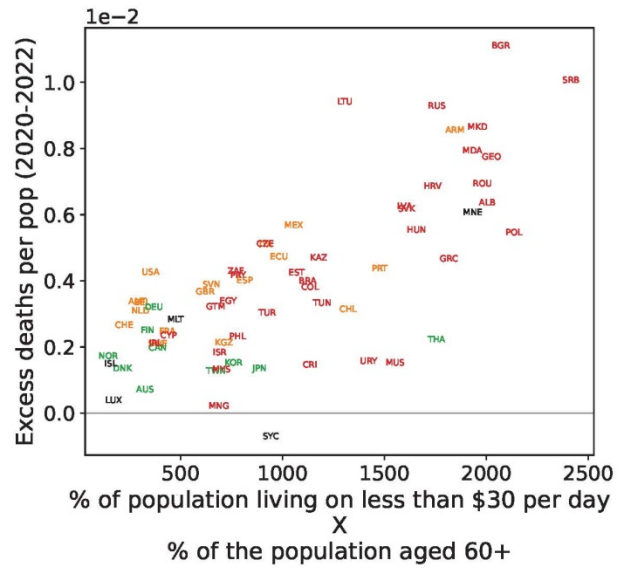
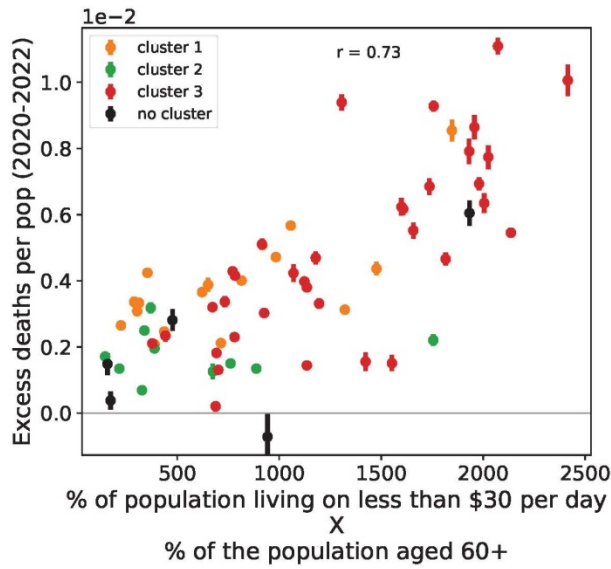


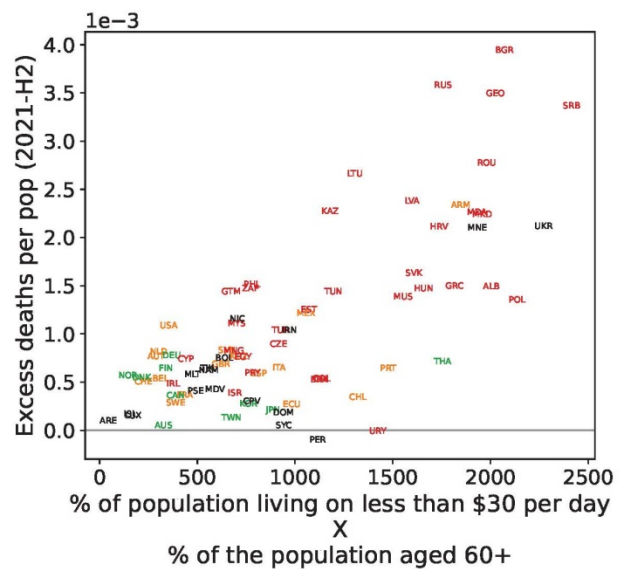
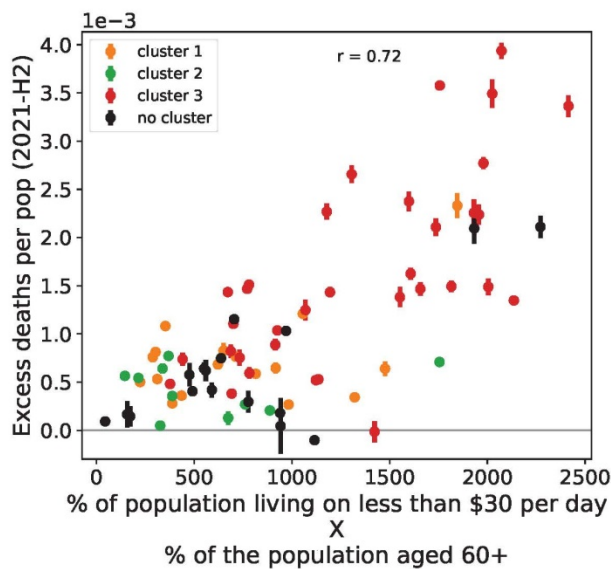
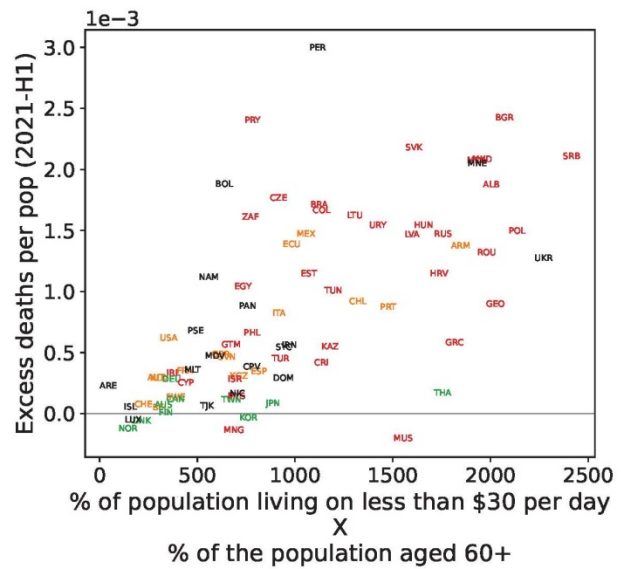
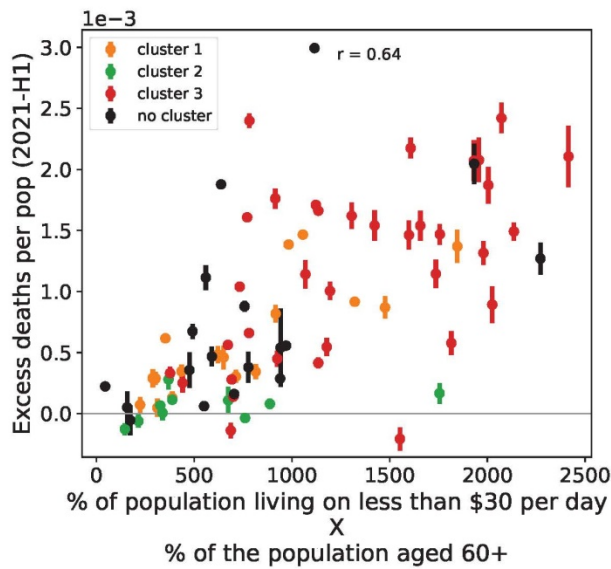
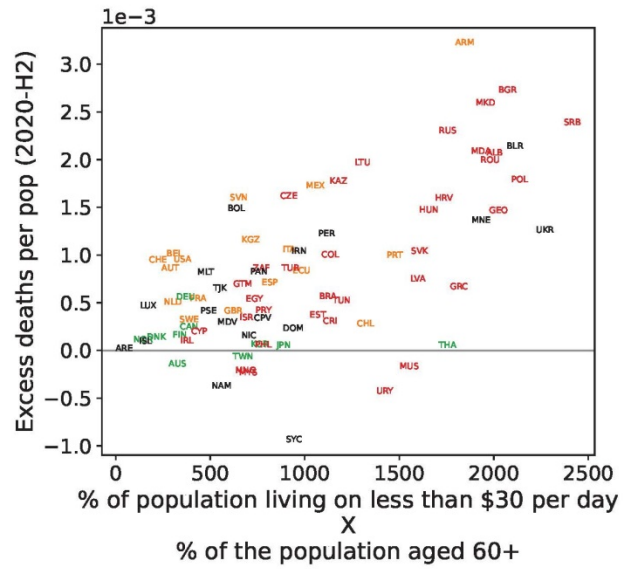
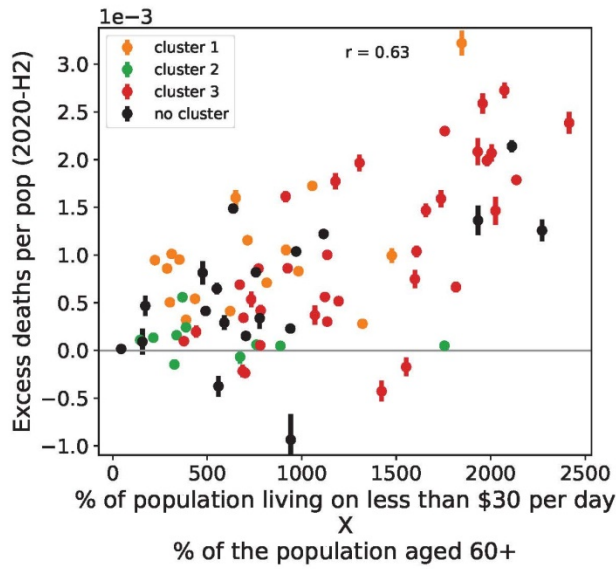
Figure 47. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus number of vaccine injections by 2019 population for the vaccination period 2022 (WHO data), with 1σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.

4.18 Excess all-cause mortality correlations with products of socio-economic variables

We examined correlations of excess all-cause mortality with products of two socio-economic variables. We considered many products between one economic variable (share of population living with less than \$X/day, mean income per day) and one population health variable (share of population aged X+, life expectancy at age X).

The main high correlation coefficient occurred for the product of share of population living with less than \$30/day and share of population aged 60+, for excess all-cause mortality expressed as a fraction of 2019 population. The Pearson correlation coefficient between this excess all-cause mortality during the Covid period (2020-2023-H1) and this product is +0.78 (“strong”, following Evans, 1996), whereas the correlation coefficients to the individual variables are +0.49 (“moderate”, share of population living with \leq \$30/day, Figure 37) and +0.37 (“weak”, share of population aged 60+, Figure 40). The correlations to the product is shown in Figure 48.





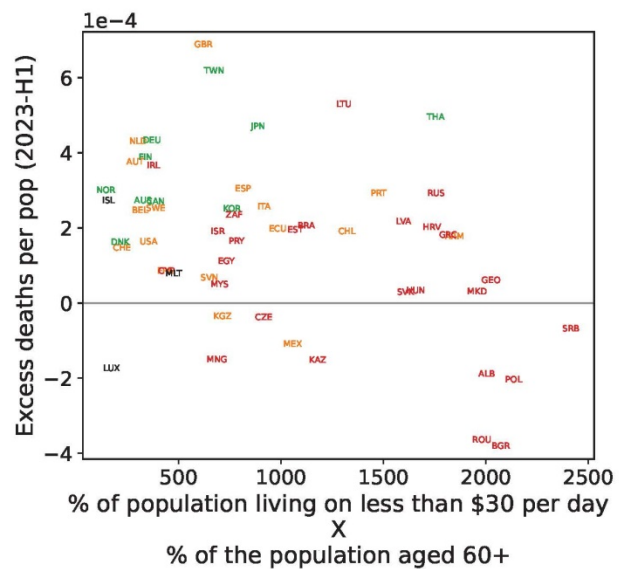
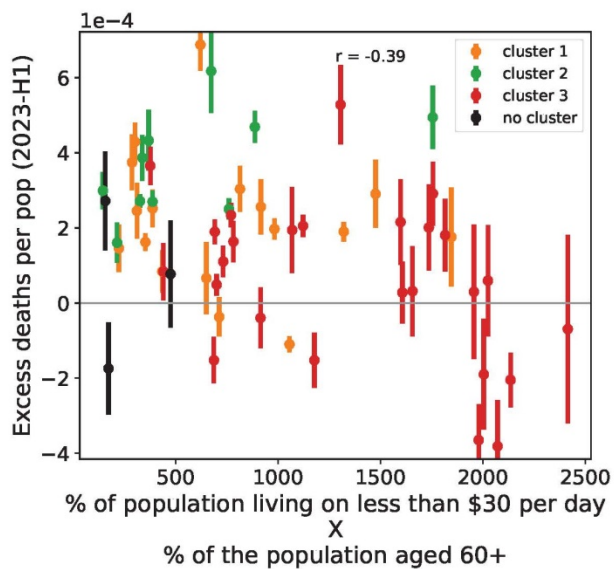
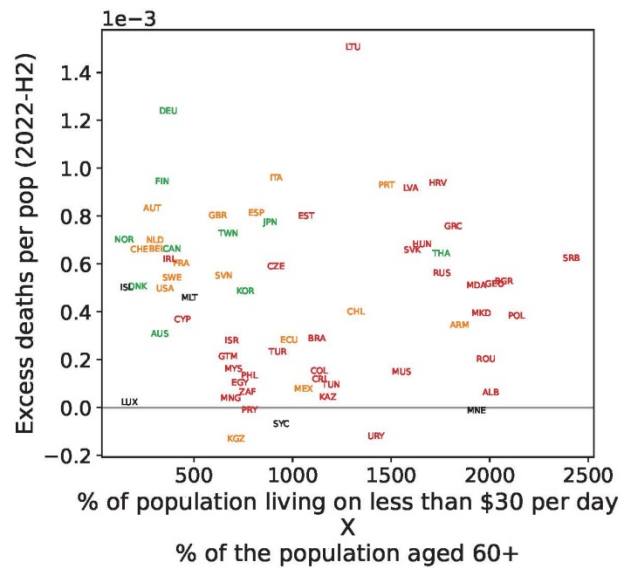
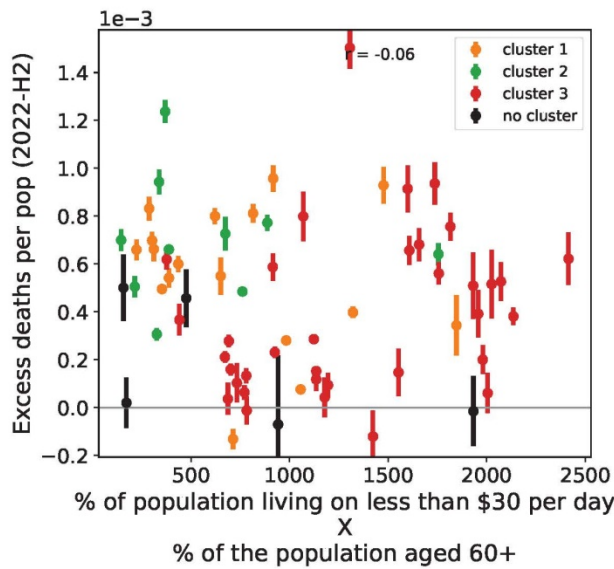
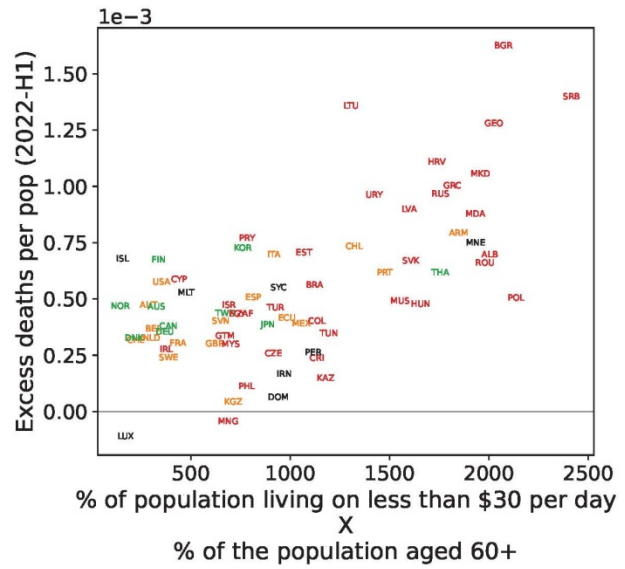
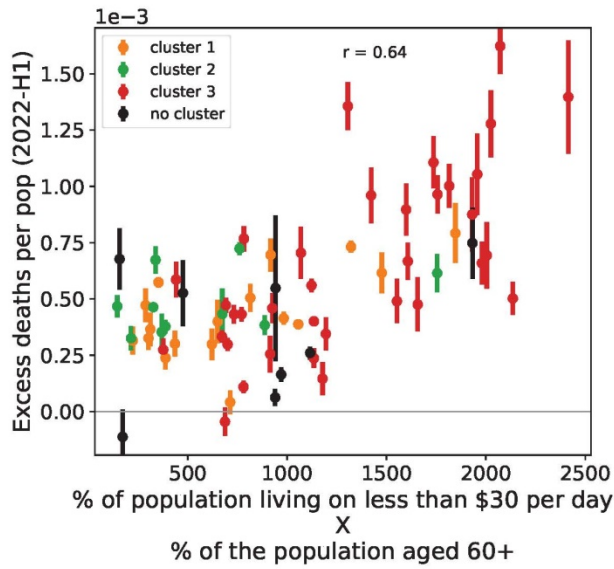


Figure 48. Excess all-cause mortality for the Covid period (2020-2022 and 2020-2023-H1) and for each half year 2020-H1 to 2023-H1, as labelled, top to bottom twin panels, expressed as a fraction of 2019 population, versus the product of share of population living with less than \$30/day and share of population aged 60+, with 1 σ error bars (left panels) and country codes (right panels). The colours correspond to the three clusters from the cluster analysis. The corresponding Pearson correlation coefficient is given in each twin panel.

Table 2 compares the Pearson correlation coefficients for the two individual variables and for the product variable, for the different time period during the Covid period (from Figure 37, Figure 40, and Figure 48, respectively).

Table 2. Pearson correlation coefficients of excess all-cause mortality by population with two variables, their product, and for different time periods in the Covid period *

Time period	Living \leq \$30/day	Share pop aged 60+	Product variable
2020-2022	+0.39	+0.38	+0.73
2020-2023-H1	+0.49	+0.37	+0.78
2020-H1	-0.07	+0.07	-0.08
2020-H2	+0.29	+0.25	+0.63
2021-H1	+0.49	+0.12	+0.64
2021-H2	+0.38	+0.24	+0.72
2022-H1	+0.16	+0.44	+0.64
2022-H2	-0.56	+0.70	-0.06
2023-H1	-0.45	+0.24	-0.39

* Here, the orange and blue colours are used to draw attention to differences between values for individual variables and the product variable, for the full Covid period and some half years, respectively.

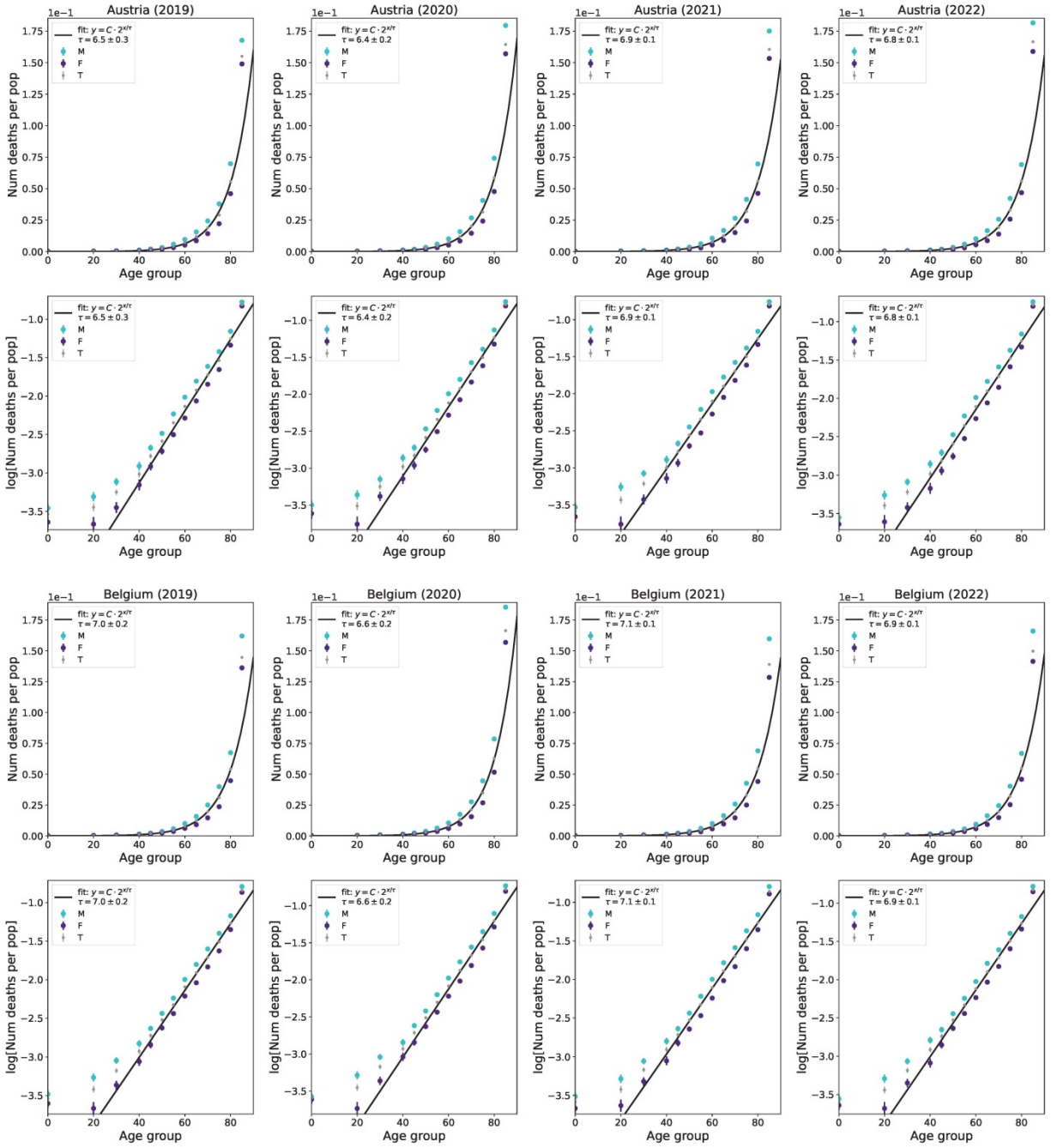
4.19 Age dependence of excess all-cause mortality in European countries during the Covid period

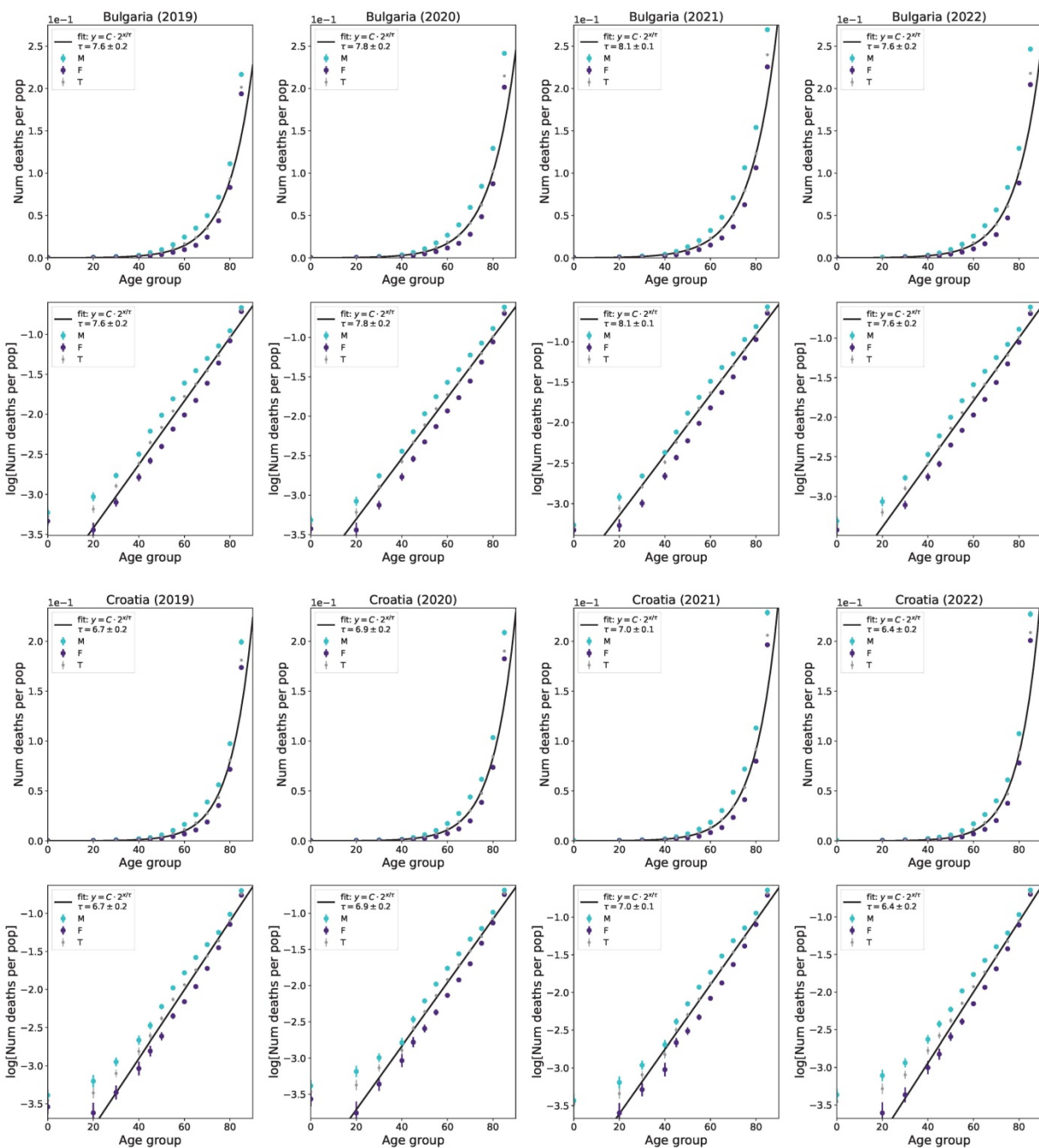
Several European countries have available all-cause mortality data discriminated by age group and by sex. Twenty five countries have such data of sufficient quality to allow the analyses of the present section: Austria, Belgium, Bulgaria, Croatia, Czechia,

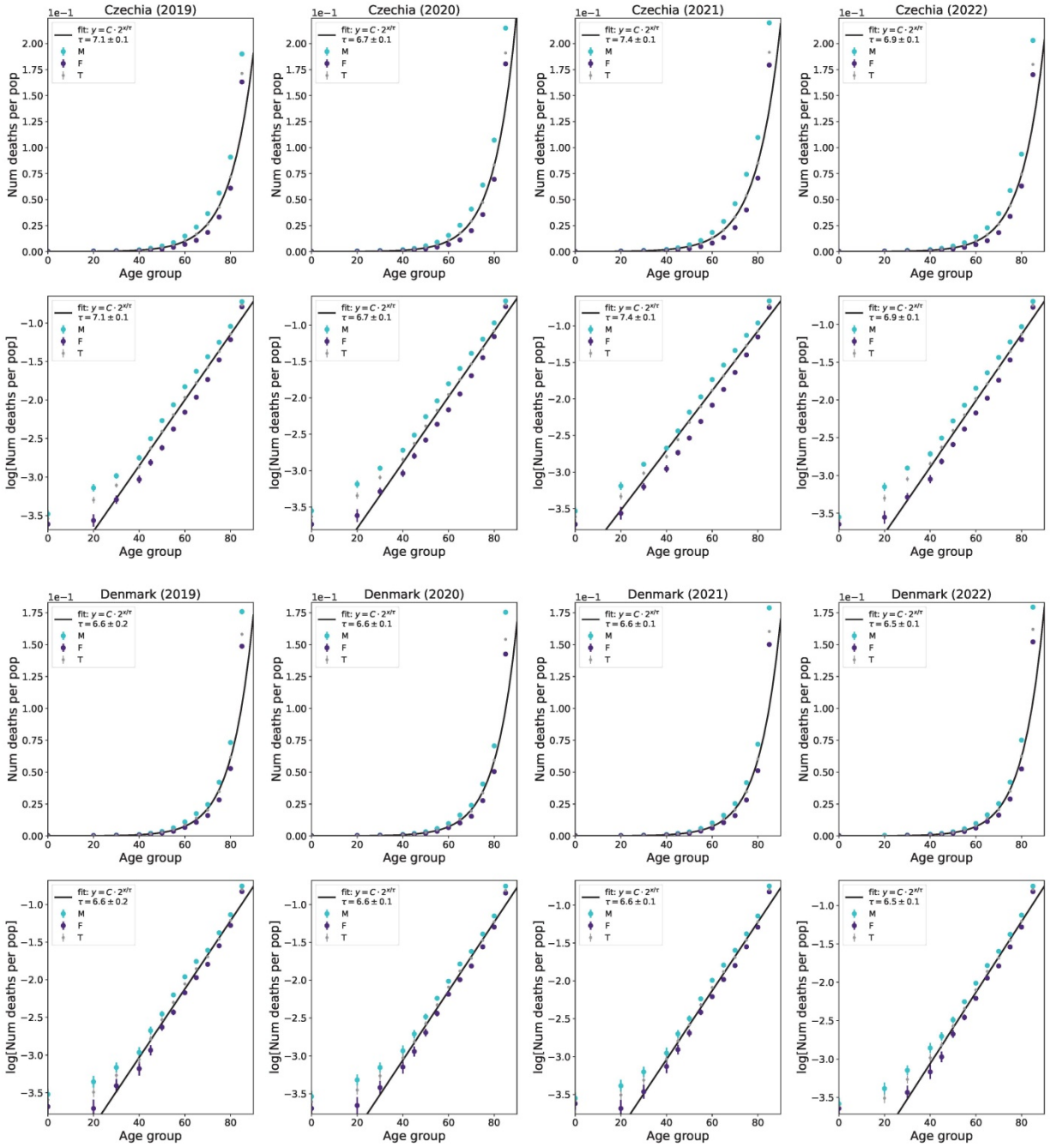
Denmark, Estonia, Finland, France, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, and Switzerland.

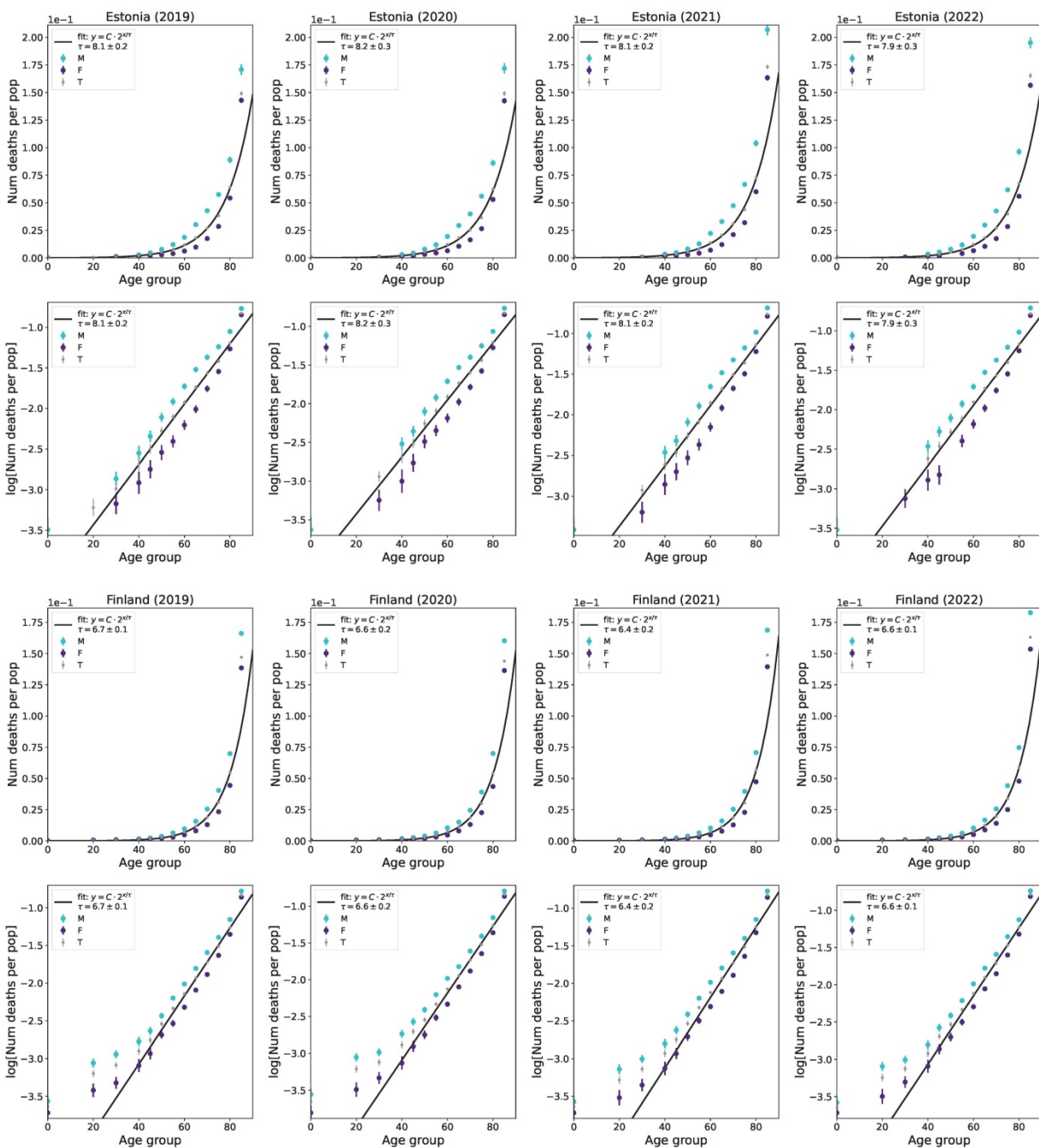
First, we examine the age dependence of yearly all-cause mortality itself, by sex, for the years 2019, 2020, 2021 and 2022, normalized by population of sex and age group per given year. For this, and below, we define the thirteen age groups: 0-19, 20-29, 30-39, 40-44, 45-49, 50-54, ..., 80-84, and 85+.

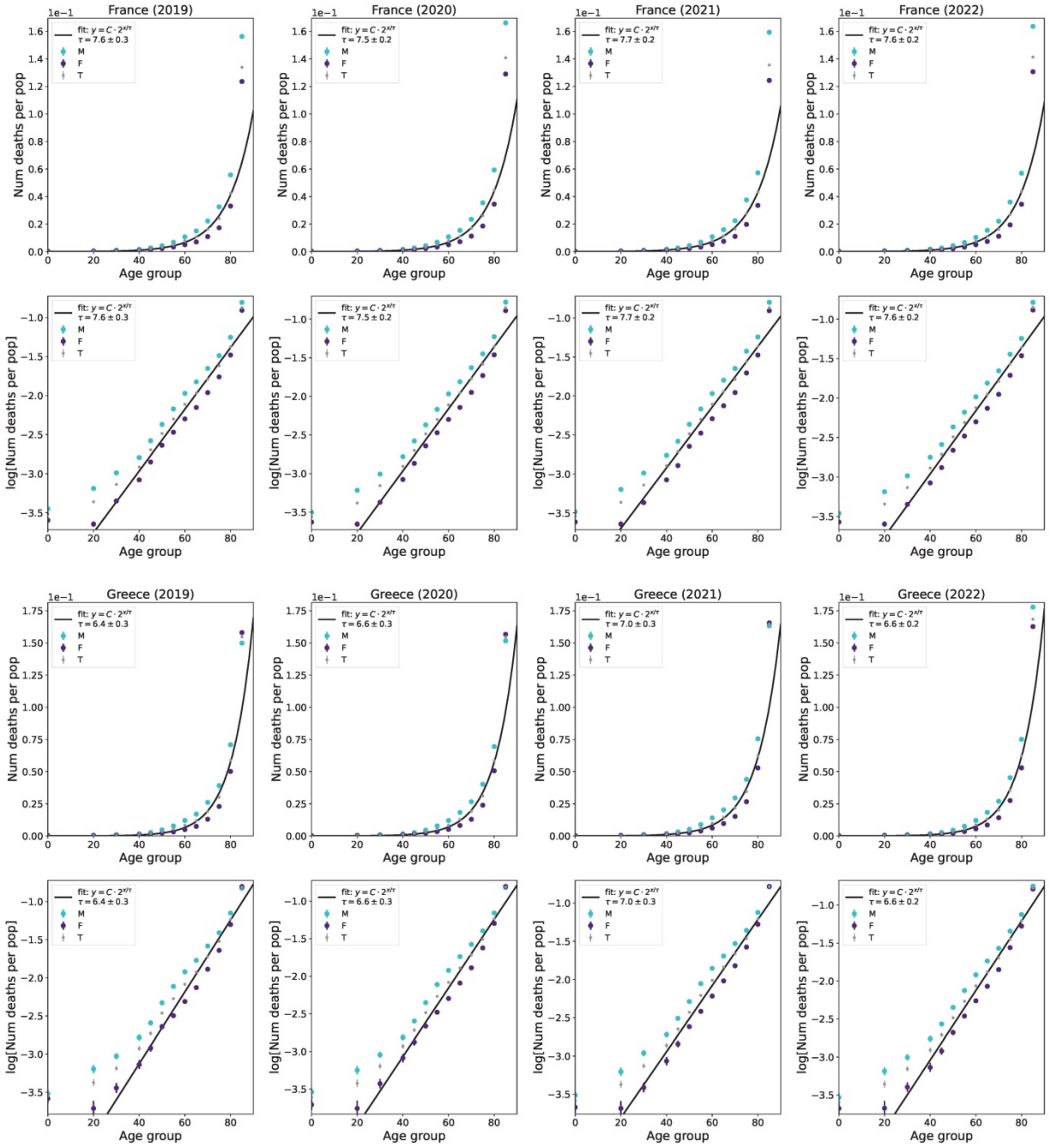
Figure 49 shows yearly population-normalized all-cause mortality, by sex, versus age group for the 25 European countries (as labelled) and for the years 2019 through 2022 (as labelled), for both linear (top panels) and logarithmic (bottom panels) mortality scales. Exponential fits of the non-sex-discriminated data, over the age-group range 30-39, 40-44 through 80-84 are also shown. The values of the doubling age (τ , in years, with 1σ fitting error) corresponding to each of the exponential fits are given in Table 3. In the exponential fits, the x-coordinate of a point is set as the starting age of the age group. Using the age-group range 40-44 through 80-84 makes a negligible difference in the exponential fit outcomes.

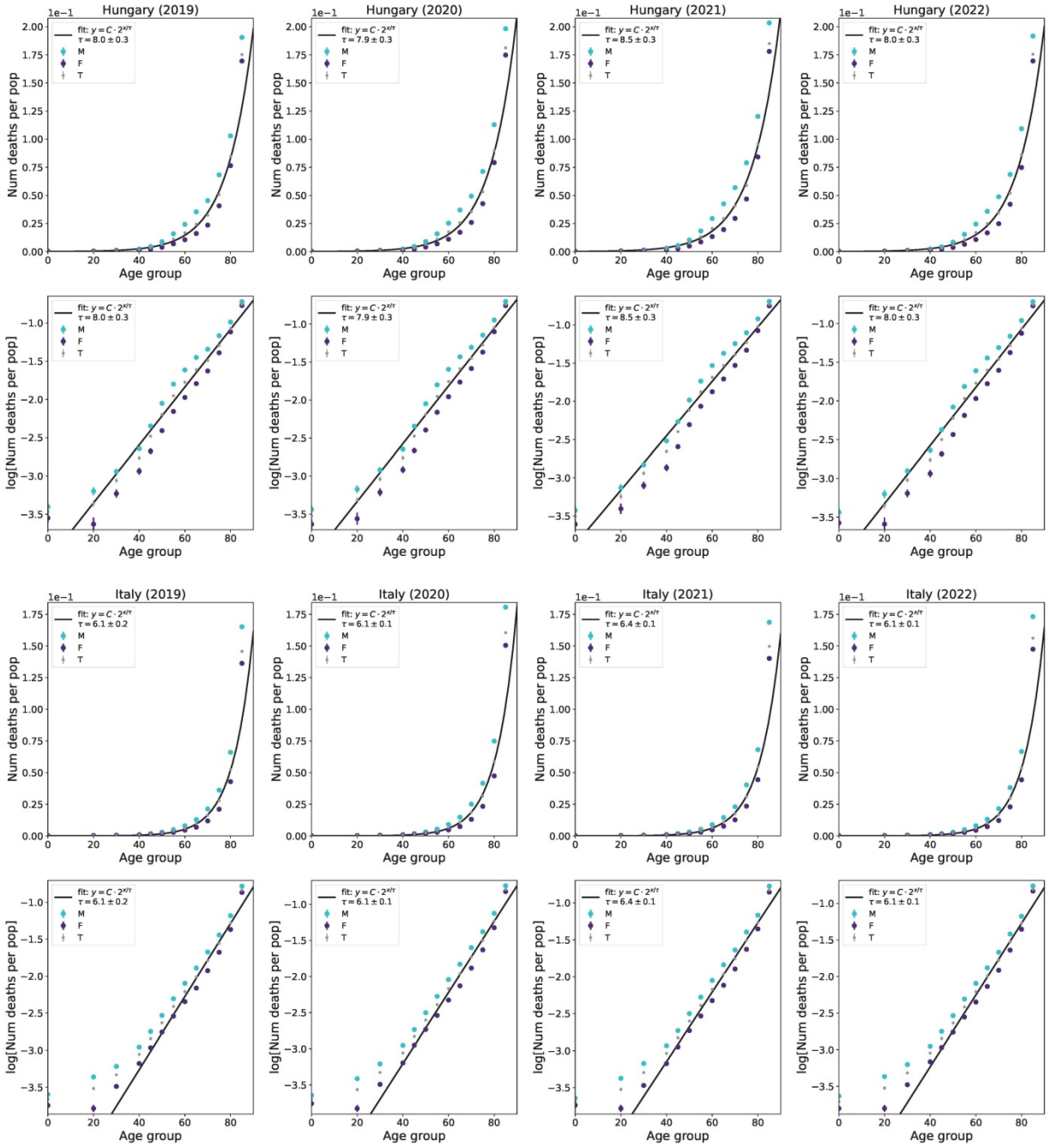


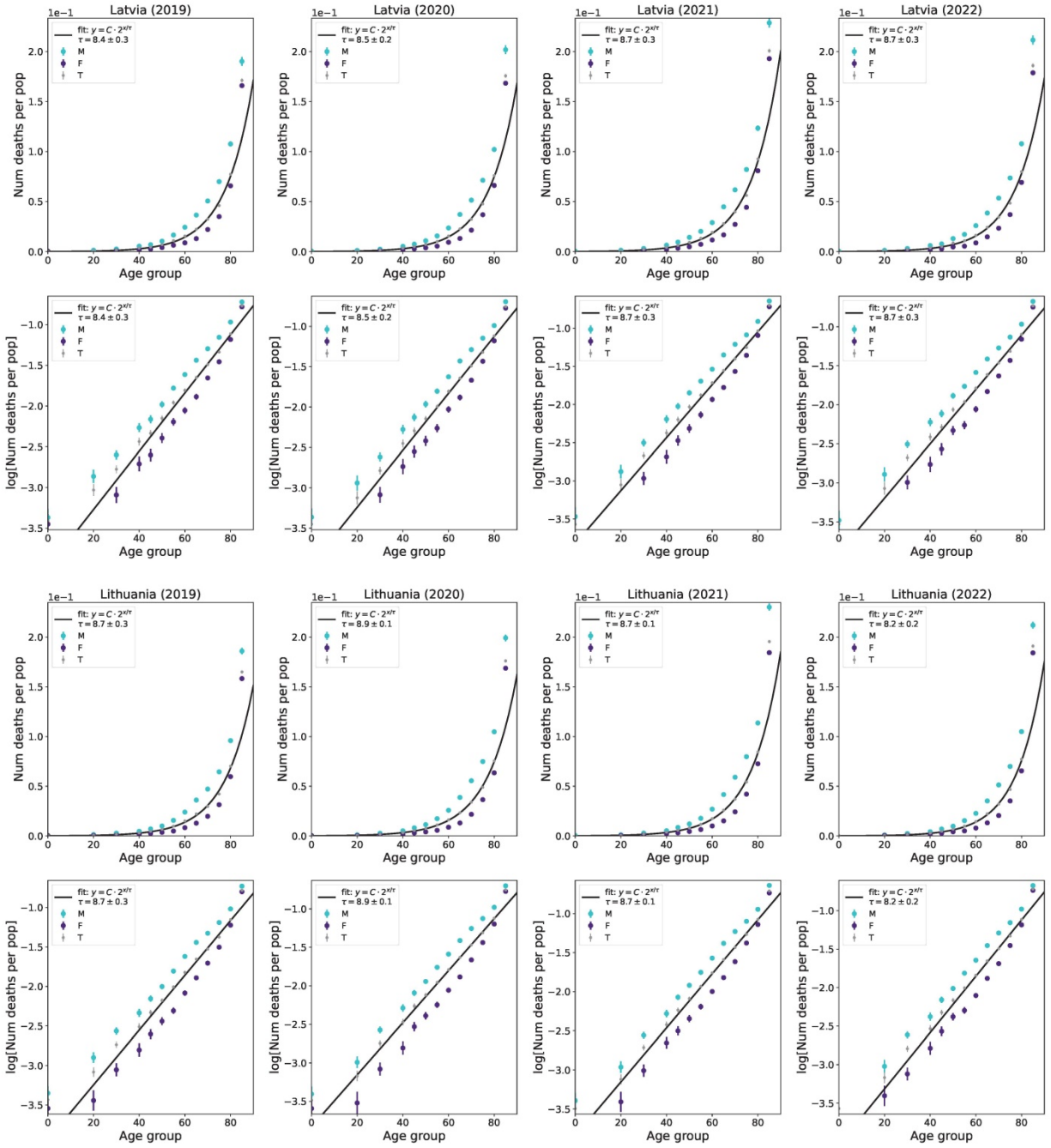


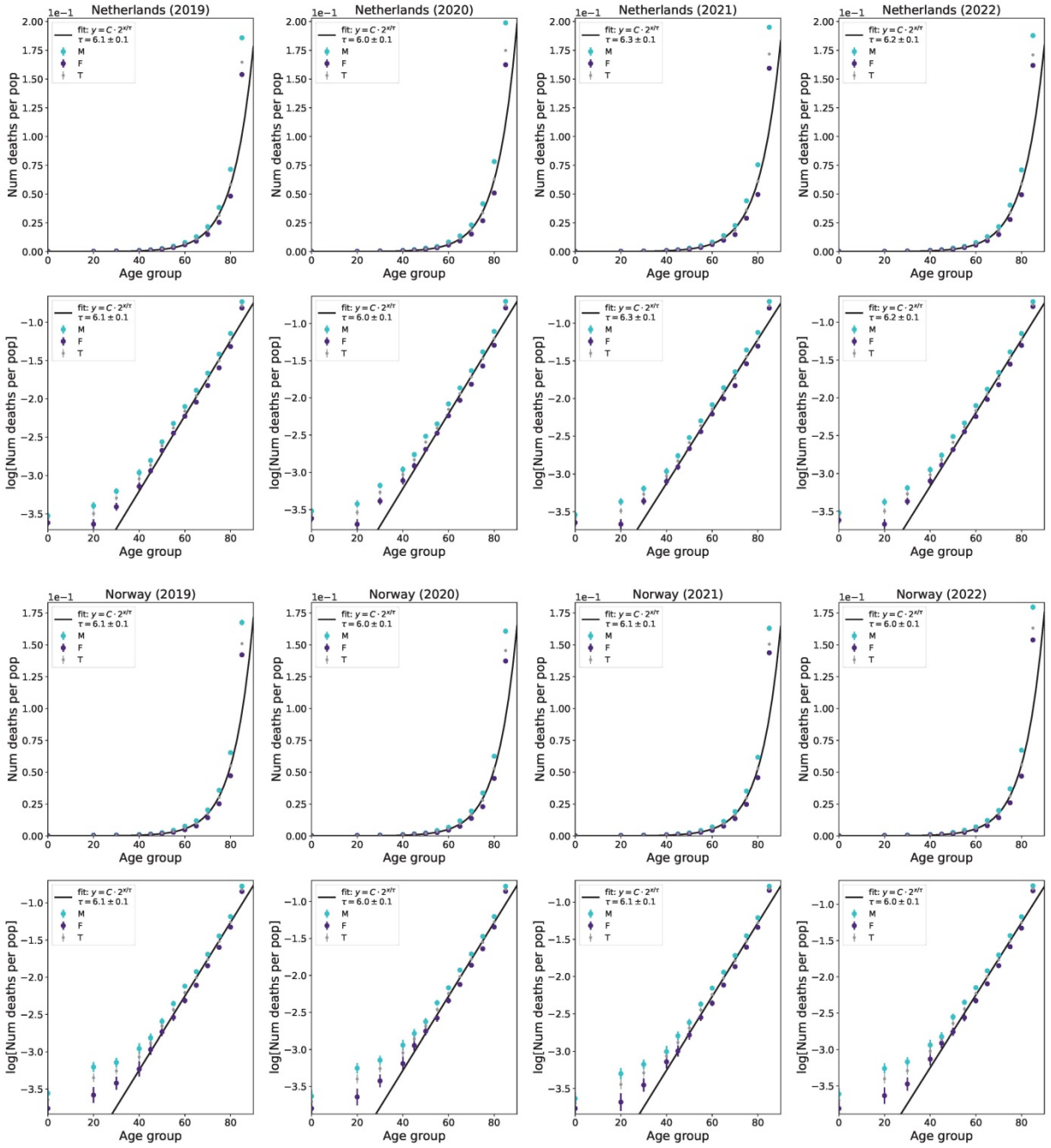


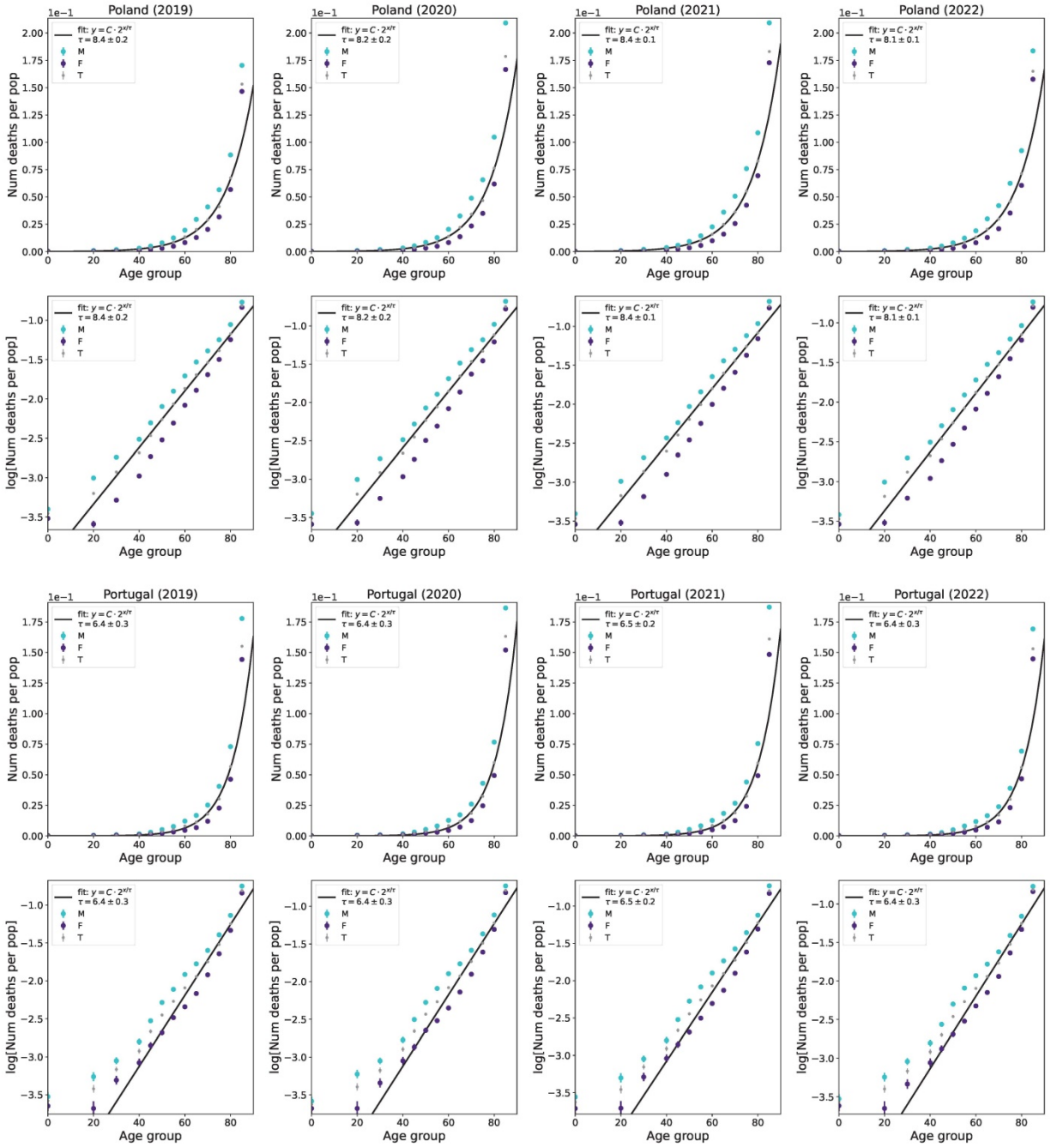


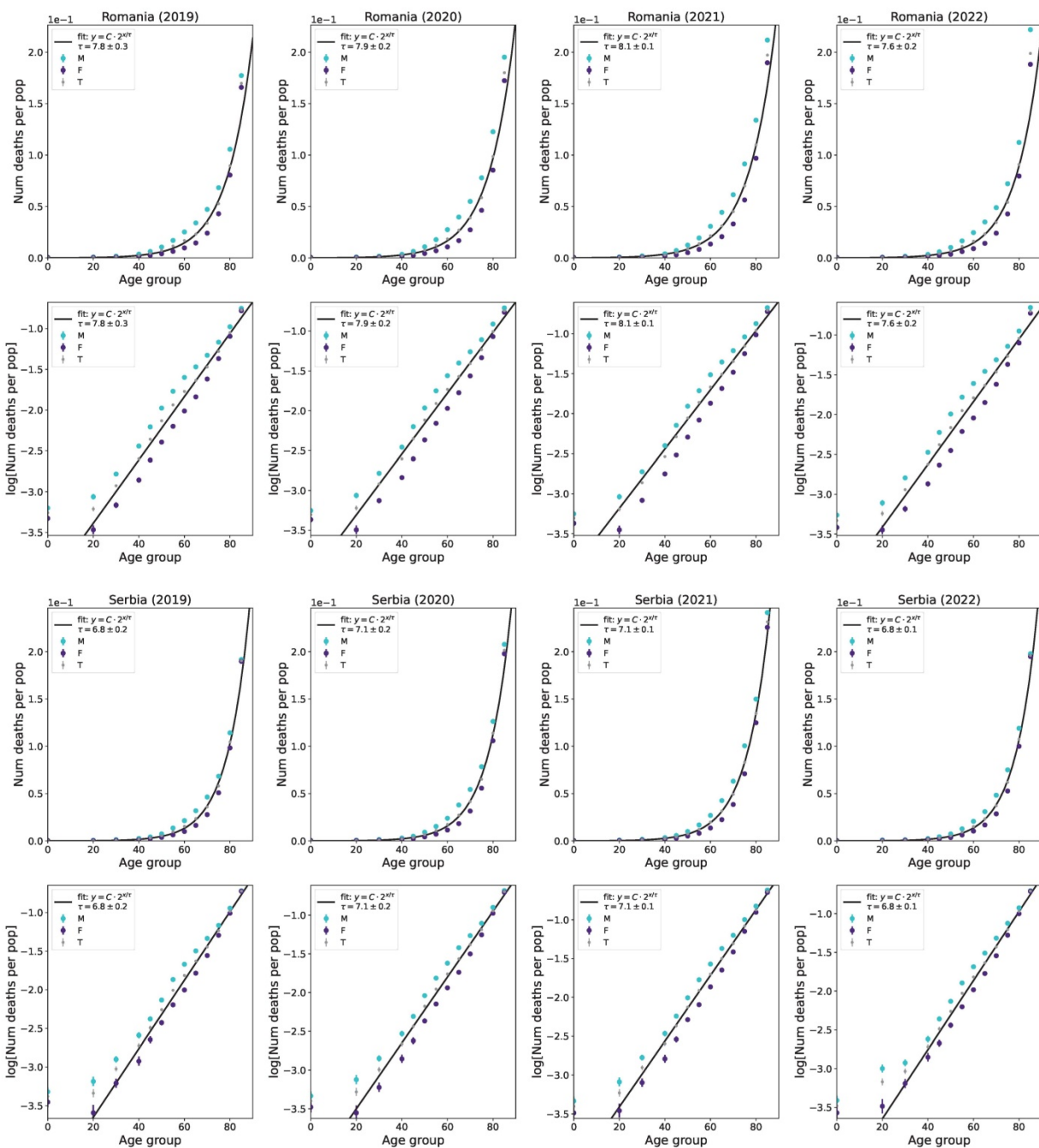


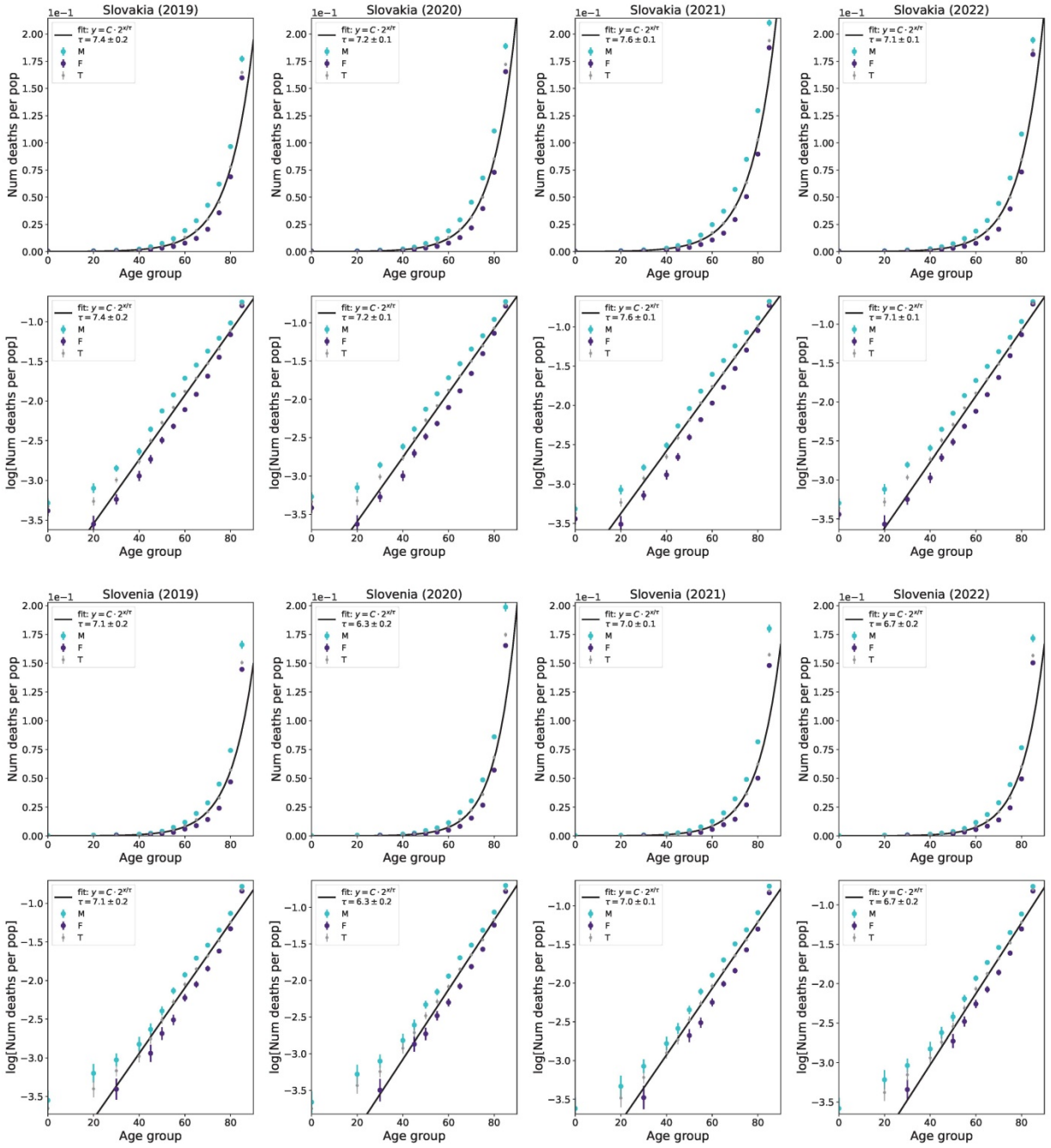


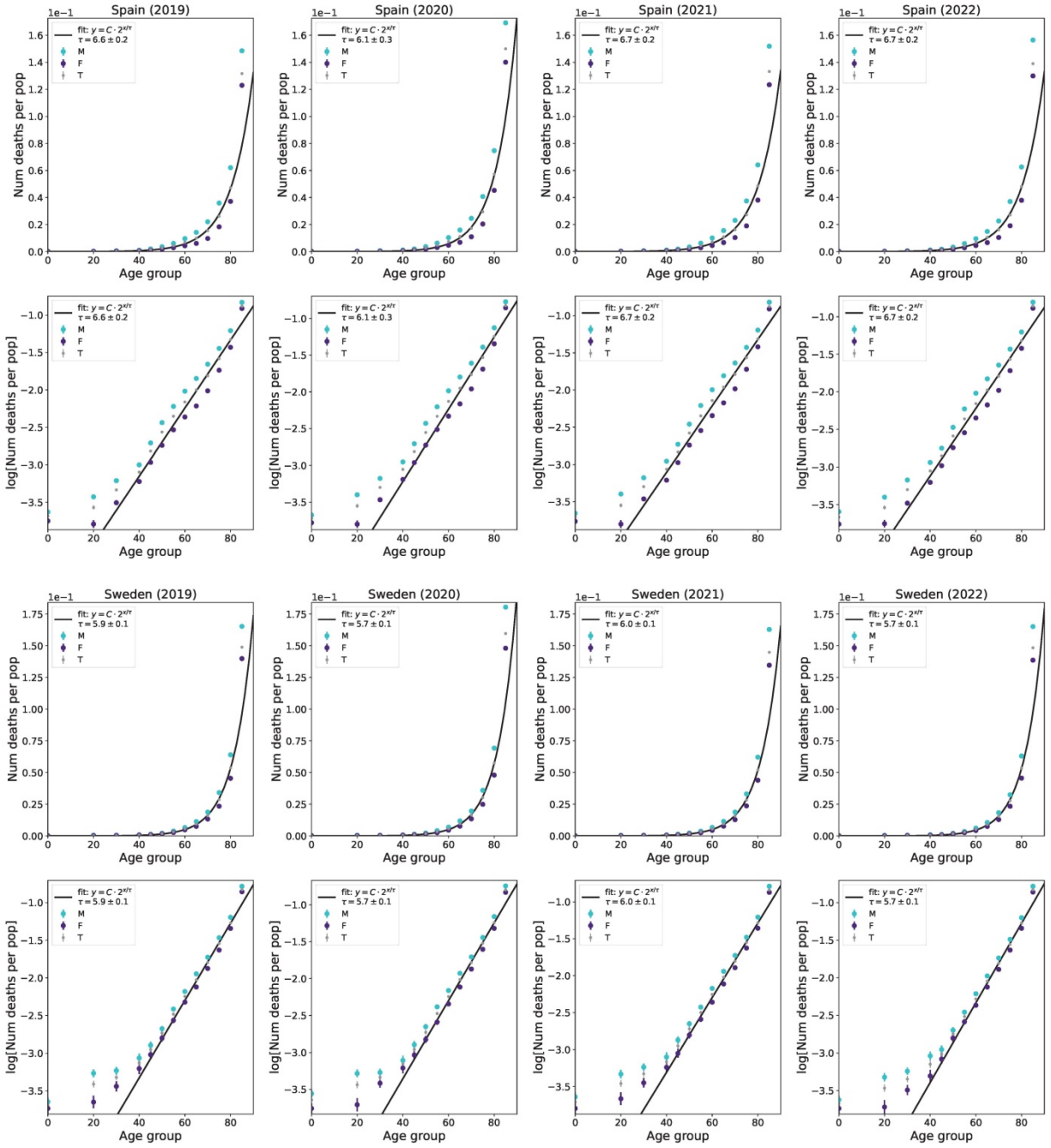












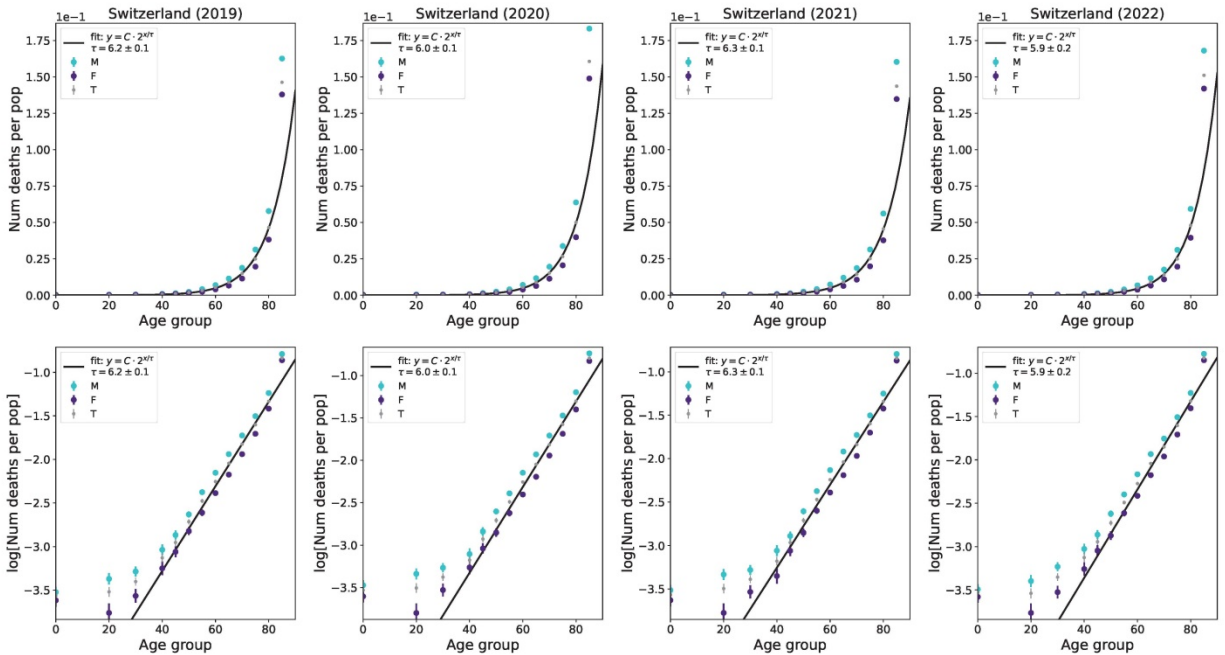


Figure 49. Yearly all-cause mortality, by sex, versus age group for 25 European countries (as labelled) and for the years 2019 through 2022 (as labelled), for both linear (top panels) and logarithmic (bottom panels) mortality scales. Normalization is by population of the age group and sex in each specific calendar year (January 1 of the year). Exponential fits of the non-sex-discriminated data, over the ten-age-group range 30-39, 40-44 to 80-84 are also shown (black lines), as are the corresponding values of the doubling age τ (in years, with 1σ fitting error).

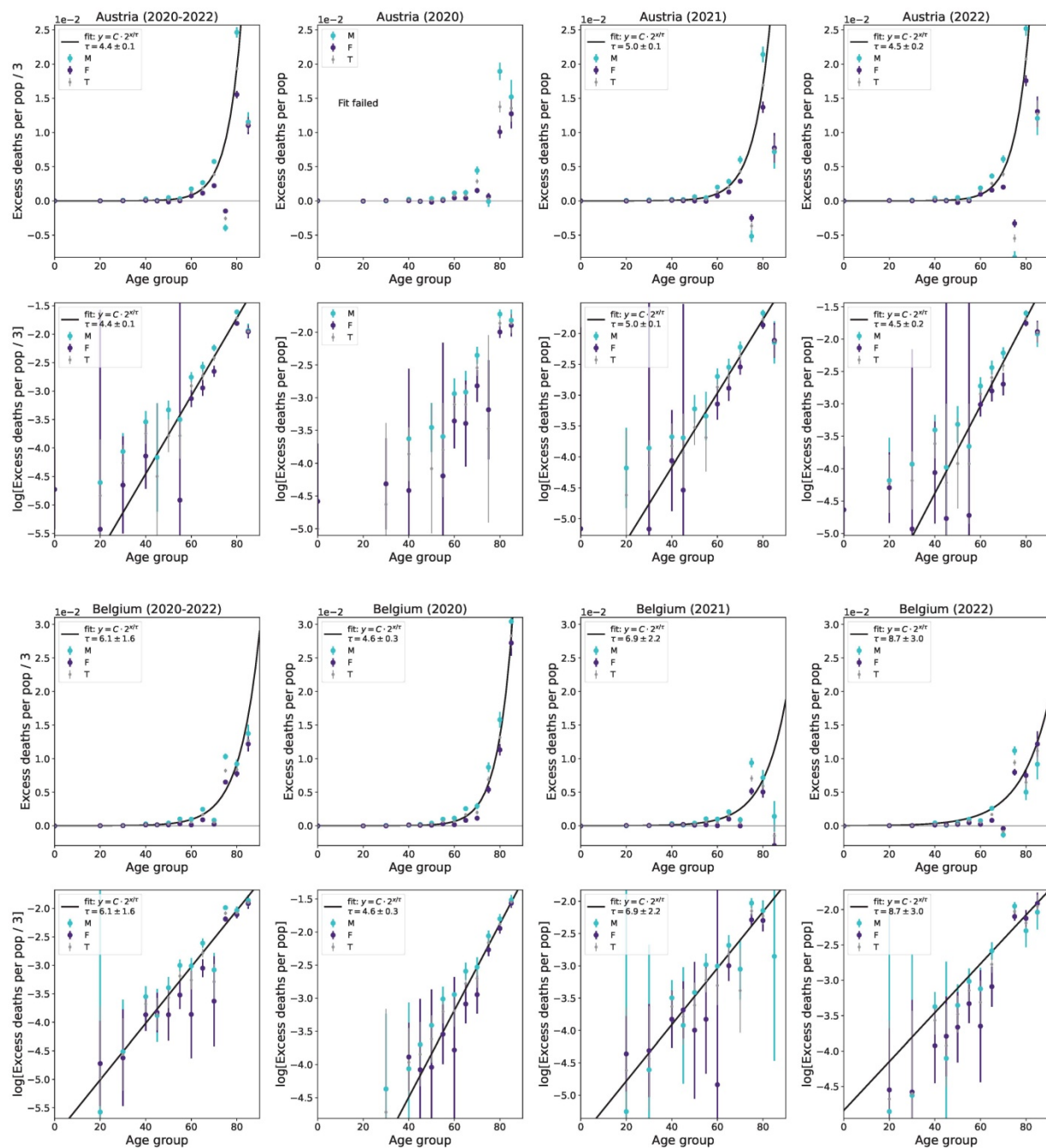
Table 3. Exponential-fit doubling age τ (in years, with 1σ fitting error) in yearly all-cause mortality (both sexes) normalized by population (per age group), using the ten age groups 30-39, 40-44 to 80-84 fitting range, by country, and by year 2019-2022.

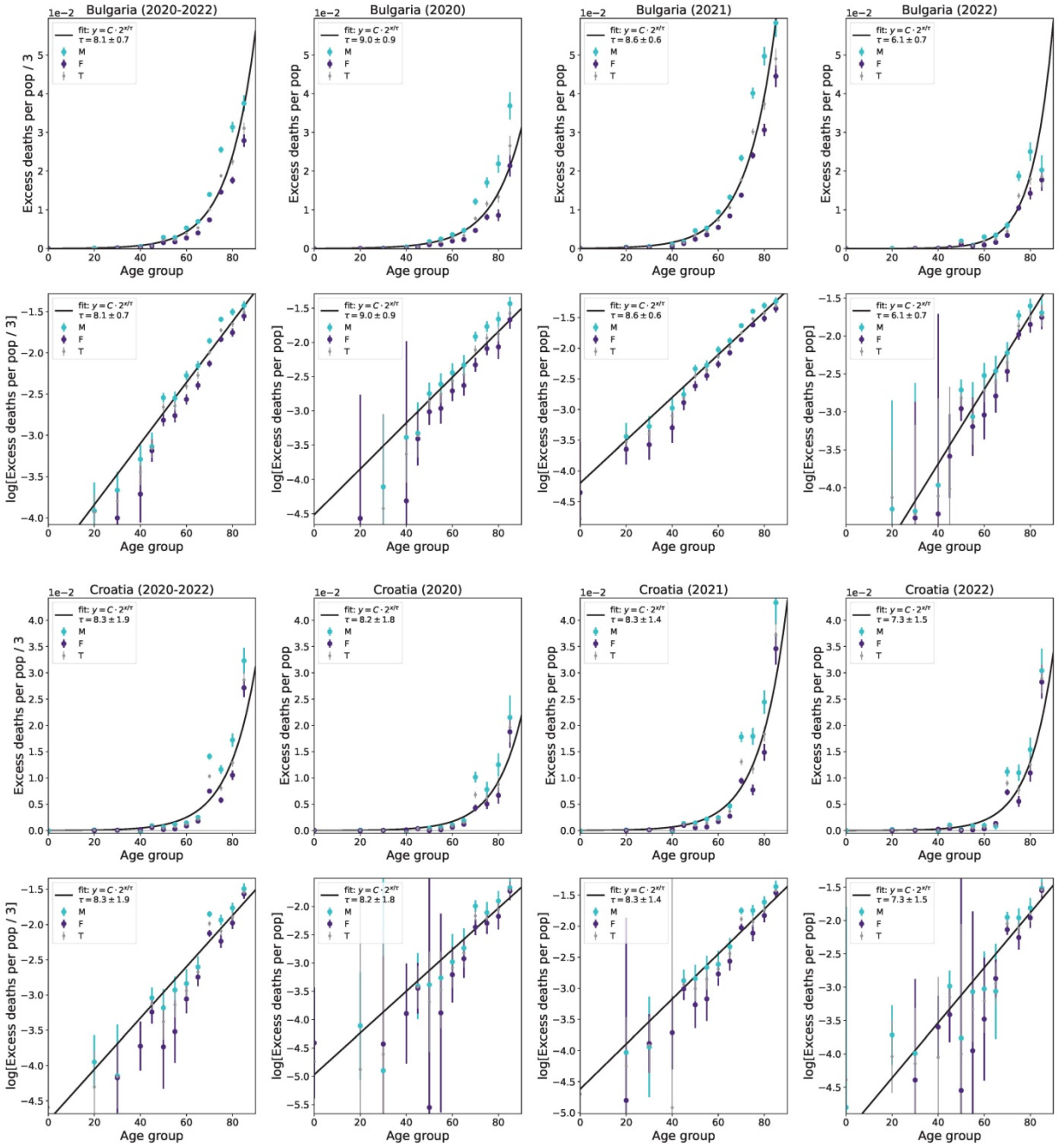
Country	2019	2020	2021	2022
Austria	6.5 (0.3)	6.4 (0.2)	6.9 (0.1)	6.8 (0.1)
Belgium	7.0 (0.2)	6.6 (0.2)	7.1 (0.1)	6.9 (0.1)
Bulgaria	7.6 (0.2)	7.8 (0.2)	8.1 (0.1)	7.6 (0.2)
Croatia	6.7 (0.2)	6.9 (0.2)	7.0 (0.1)	6.4 (0.2)
Czechia	7.1 (0.1)	6.7 (0.1)	7.4 (0.1)	6.9 (0.1)
Denmark	6.6 (0.2)	6.6 (0.1)	6.6 (0.1)	6.5 (0.1)
Estonia	8.1 (0.2)	8.2 (0.3)	8.1 (0.2)	7.9 (0.3)
Finland	6.7 (0.1)	6.6 (0.2)	6.4 (0.2)	6.6 (0.1)
France	7.6 (0.3)	7.5 (0.2)	7.7 (0.2)	7.6 (0.2)
Greece	6.4 (0.3)	6.6 (0.3)	7.0 (0.3)	6.6 (0.2)

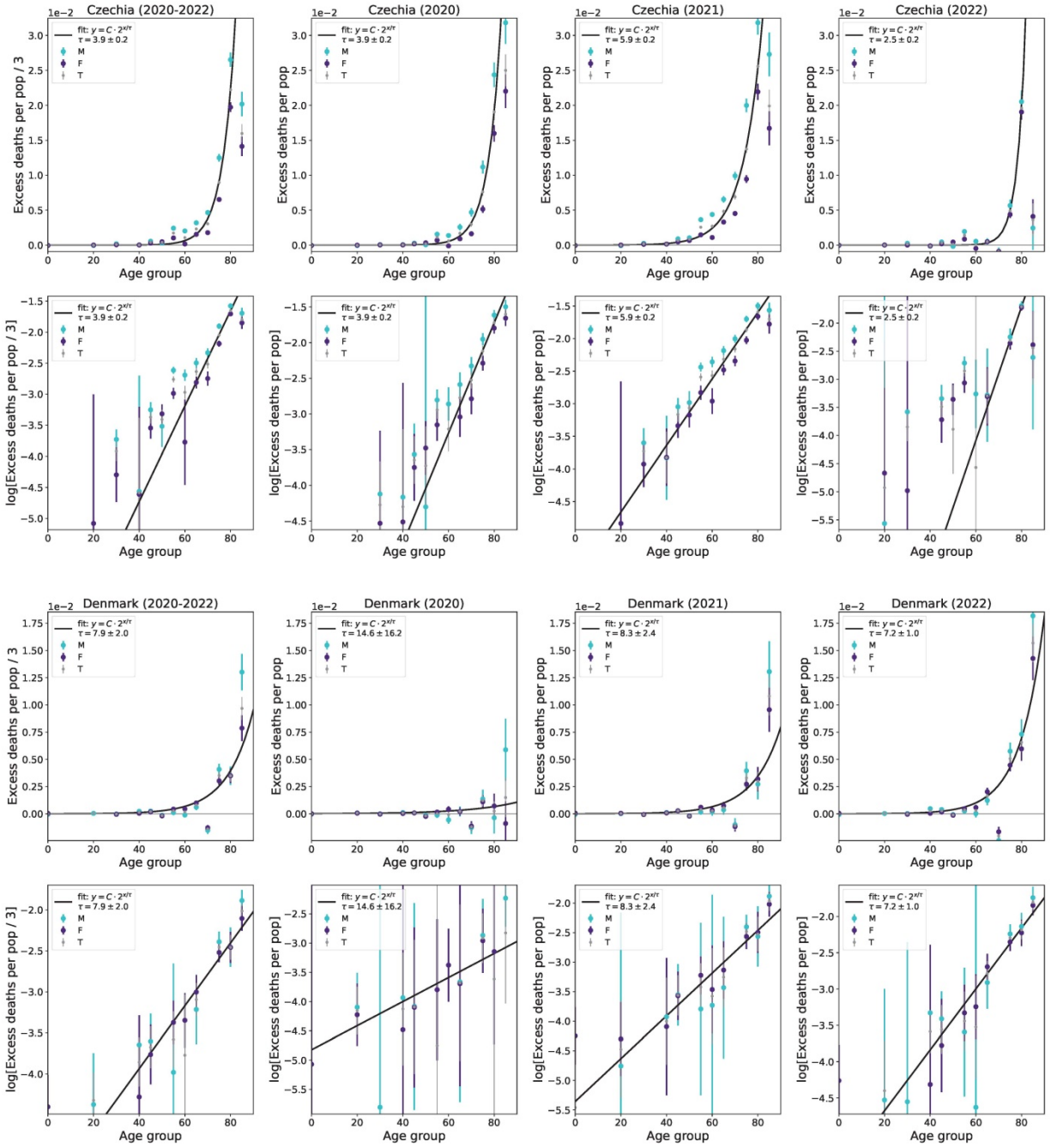
Hungary	8.0 (0.3)	7.9 (0.3)	8.5 (0.3)	8.0 (0.3)
Italy	6.1 (0.2)	6.1 (0.1)	6.4 (0.1)	6.1 (0.1)
Latvia	8.4 (0.3)	8.5 (0.2)	8.7 (0.3)	8.7 (0.3)
Lithuania	8.7 (0.3)	8.9 (0.1)	8.7 (0.1)	8.2 (0.2)
Netherlands	6.1 (0.1)	6.0 (0.1)	6.3 (0.1)	6.2 (0.1)
Norway	6.1 (0.1)	6.0 (0.1)	6.1 (0.1)	6.0 (0.1)
Poland	8.4 (0.2)	8.2 (0.2)	8.4 (0.1)	8.1 (0.1)
Portugal	6.4 (0.3)	6.4 (0.3)	6.5 (0.2)	6.4 (0.3)
Romania	7.8 (0.3)	7.9 (0.2)	8.1 (0.1)	7.6 (0.2)
Serbia	6.8 (0.2)	7.1 (0.2)	7.1 (0.1)	6.8 (0.1)
Slovakia	7.4 (0.2)	7.2 (0.1)	7.6 (0.1)	7.1 (0.1)
Slovenia	7.1 (0.2)	6.3 (0.2)	7.0 (0.1)	6.7 (0.2)
Spain	6.6 (0.2)	6.1 (0.3)	6.7 (0.2)	6.7 (0.2)
Sweden	5.9 (0.1)	5.7 (0.1)	6.0 (0.1)	5.7 (0.1)
Switzerland	6.2 (0.1)	6.0 (0.1)	6.3 (0.1)	5.9 (0.2)

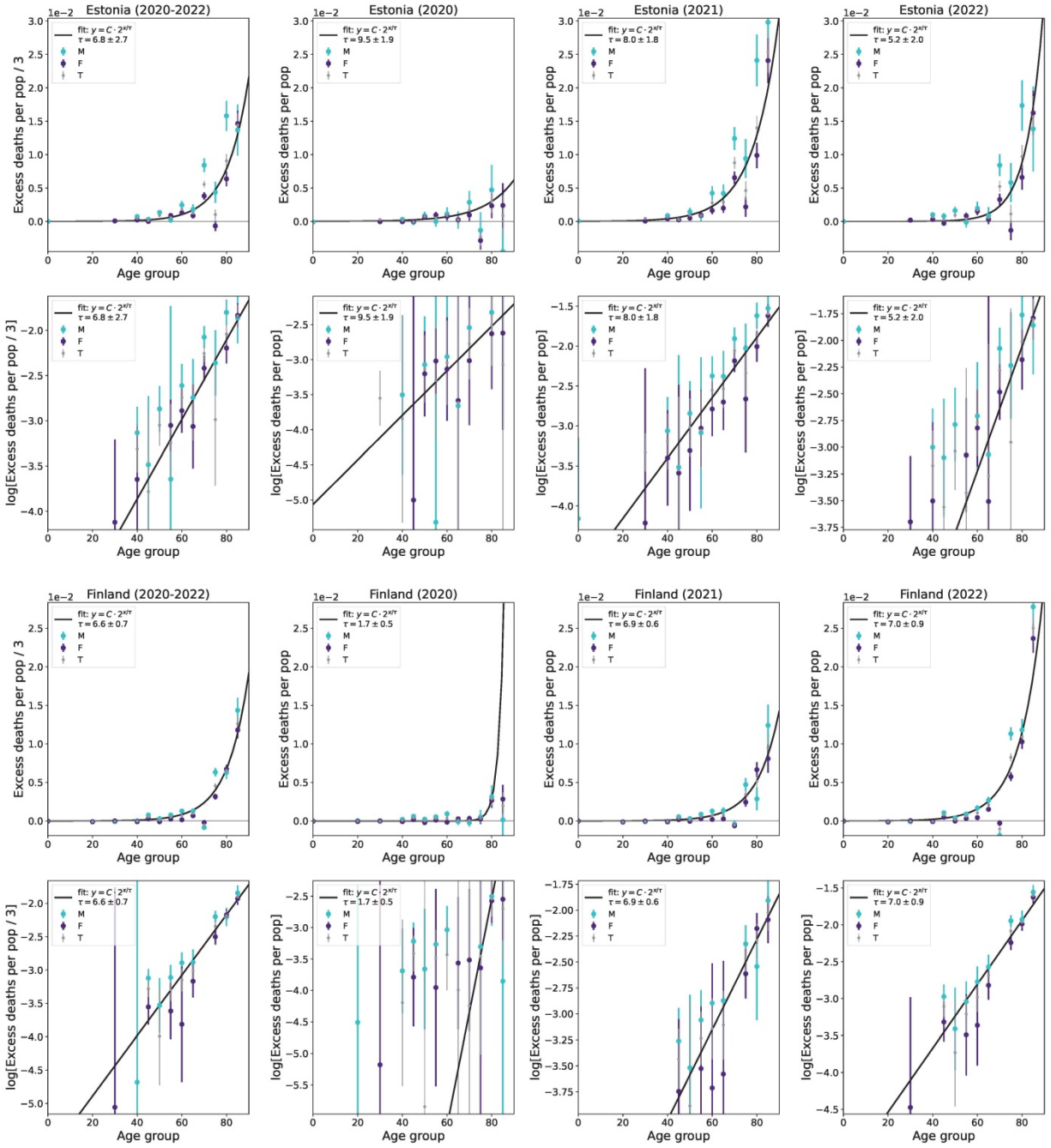
Next, we examine the age dependence of yearly excess all-cause mortality (see Methods), by sex, for the period 2020-2022 (nominally the Covid period), and for the individual years 2020, 2021 and 2022, normalized by population of sex and age group per given year, and using the population of 2021 for the 2020-2022 period. We use the same thirteen age groups as introduced above: 0-19, 20-29, 30-39, 40-44, 45-49, 50-54, ..., 80-84, and 85+.

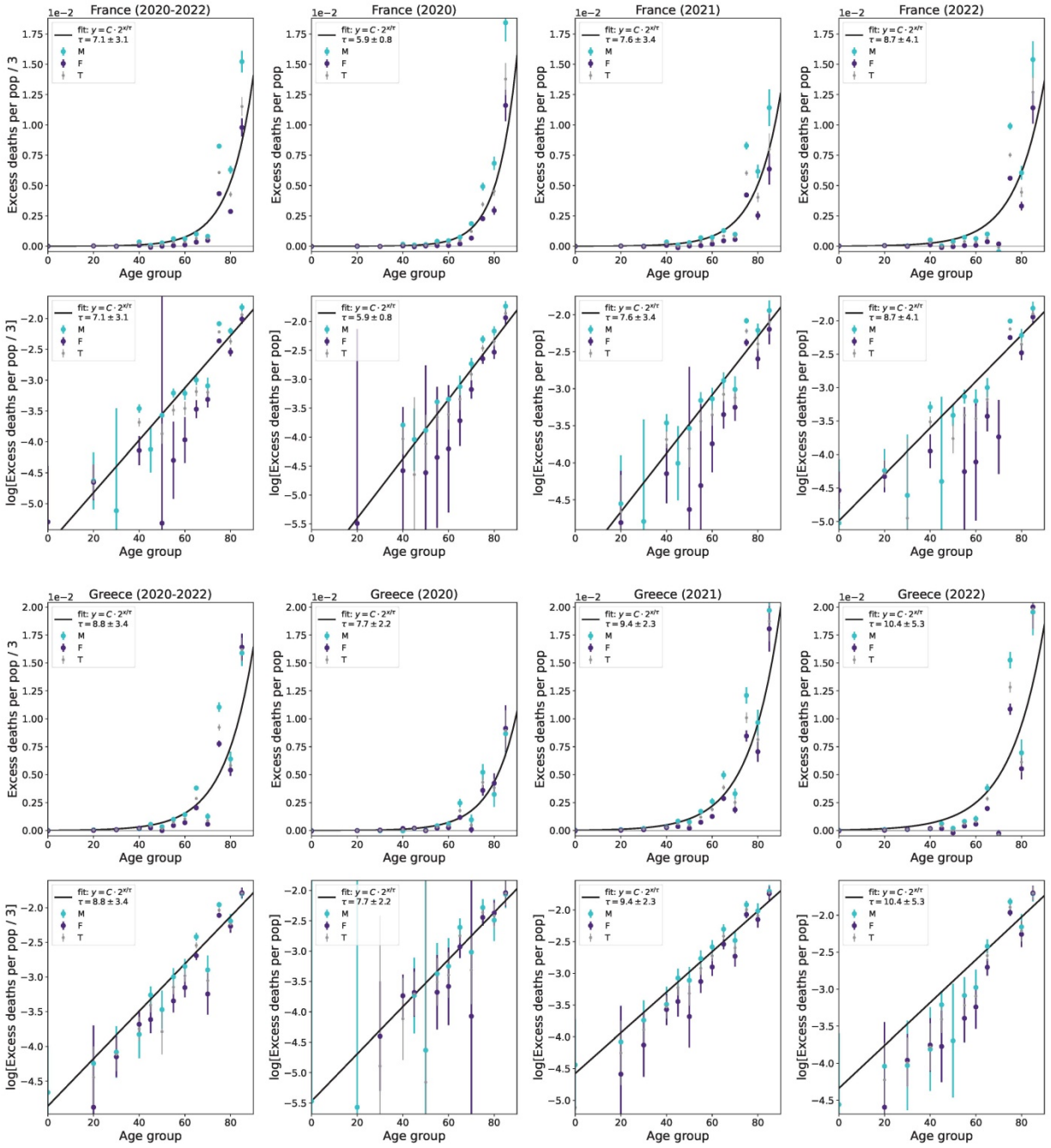
Figure 50 shows yearly population-normalized excess all-cause mortality, by sex, versus age group for the 25 European countries (as labelled) for the period 2020-2022 and for the years 2020 through 2022 (as labelled), for both linear (top panels) and logarithmic (bottom panels) mortality scales. Exponential fits of the non-sex-discriminated data, over the age-group range 30-39, 40-44 through 80-84 are also shown. The values of the doubling age (τ , in years, with 1σ fitting error) corresponding to each of the exponential fits are given in Table 4.

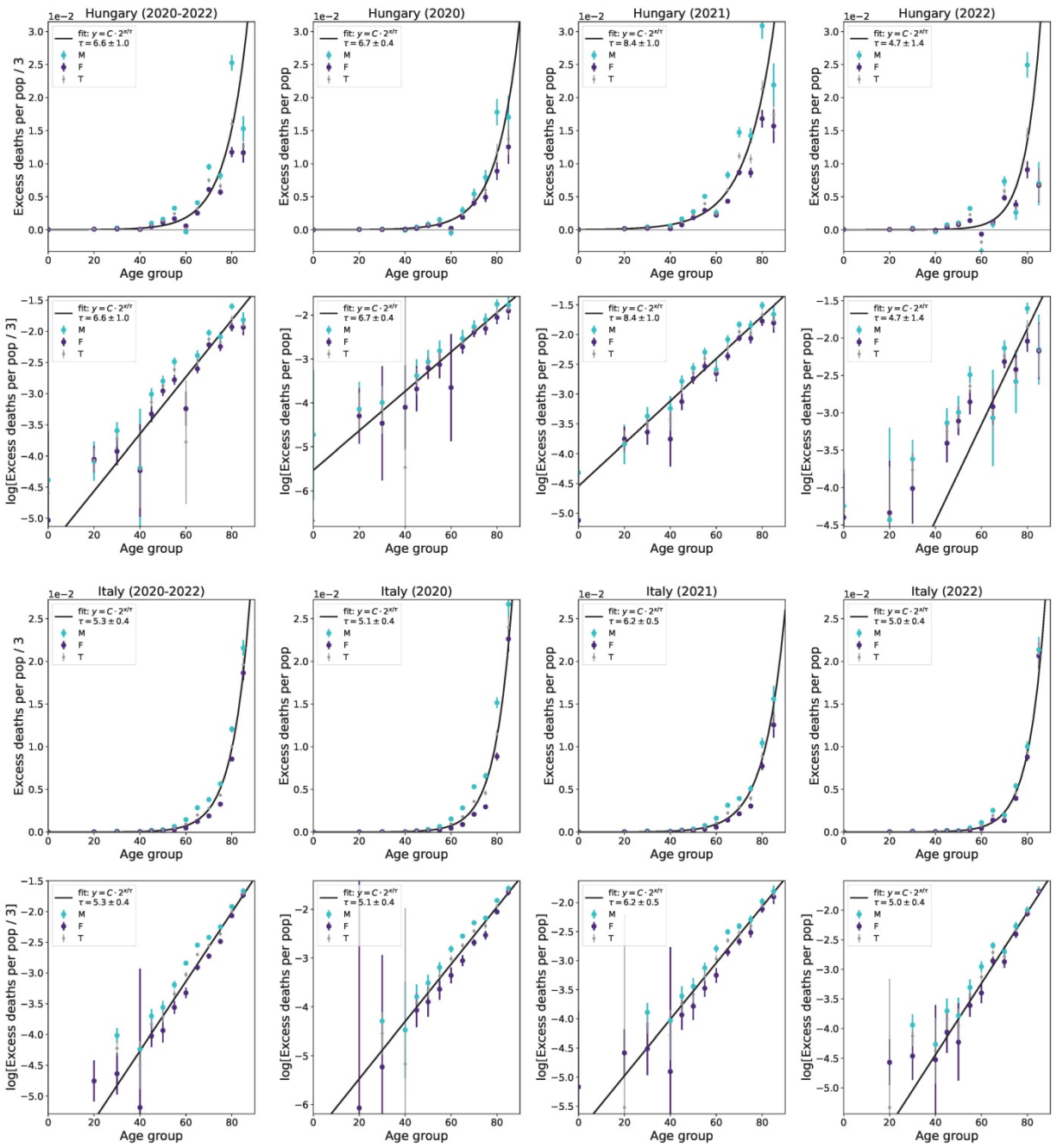


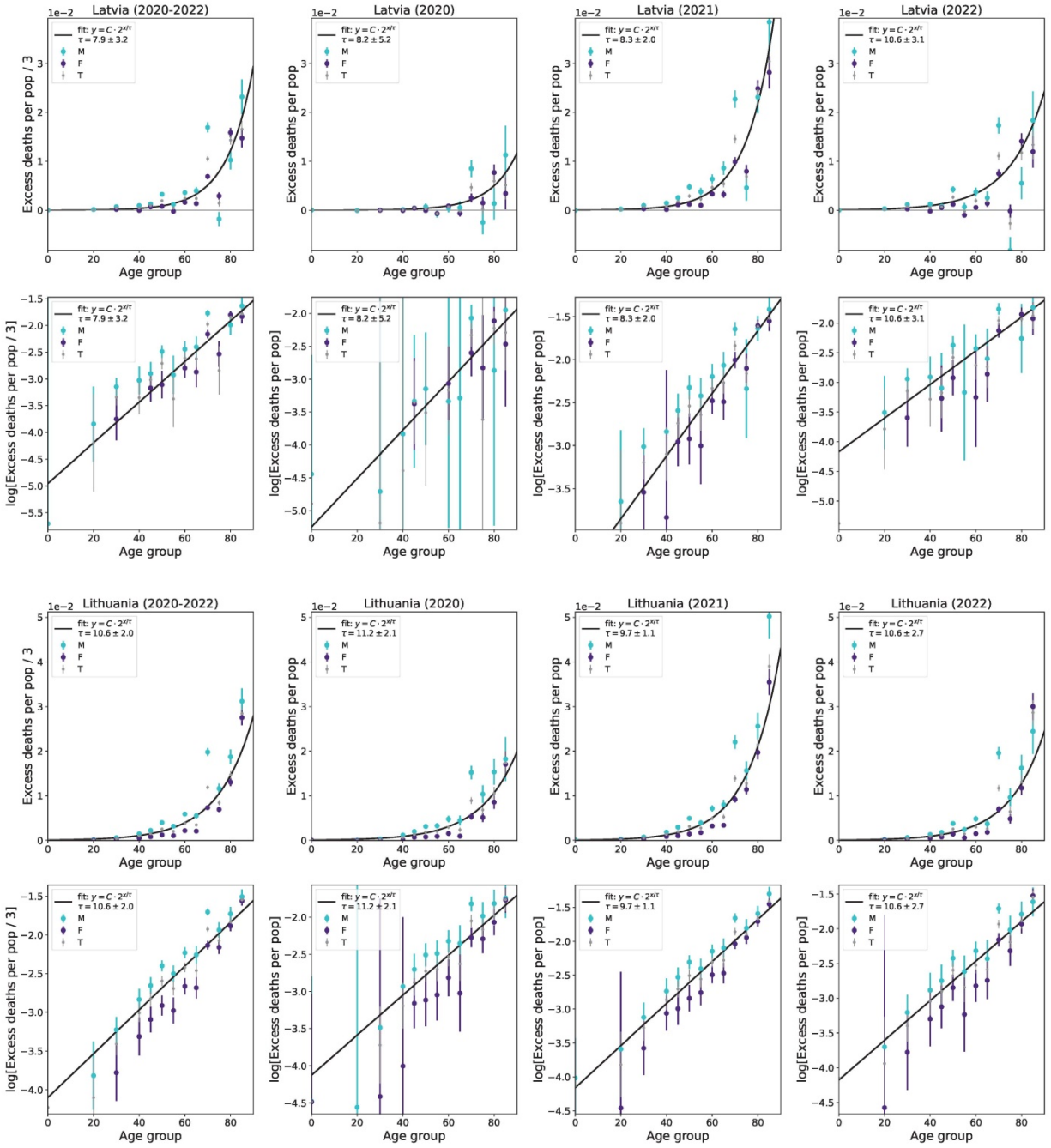


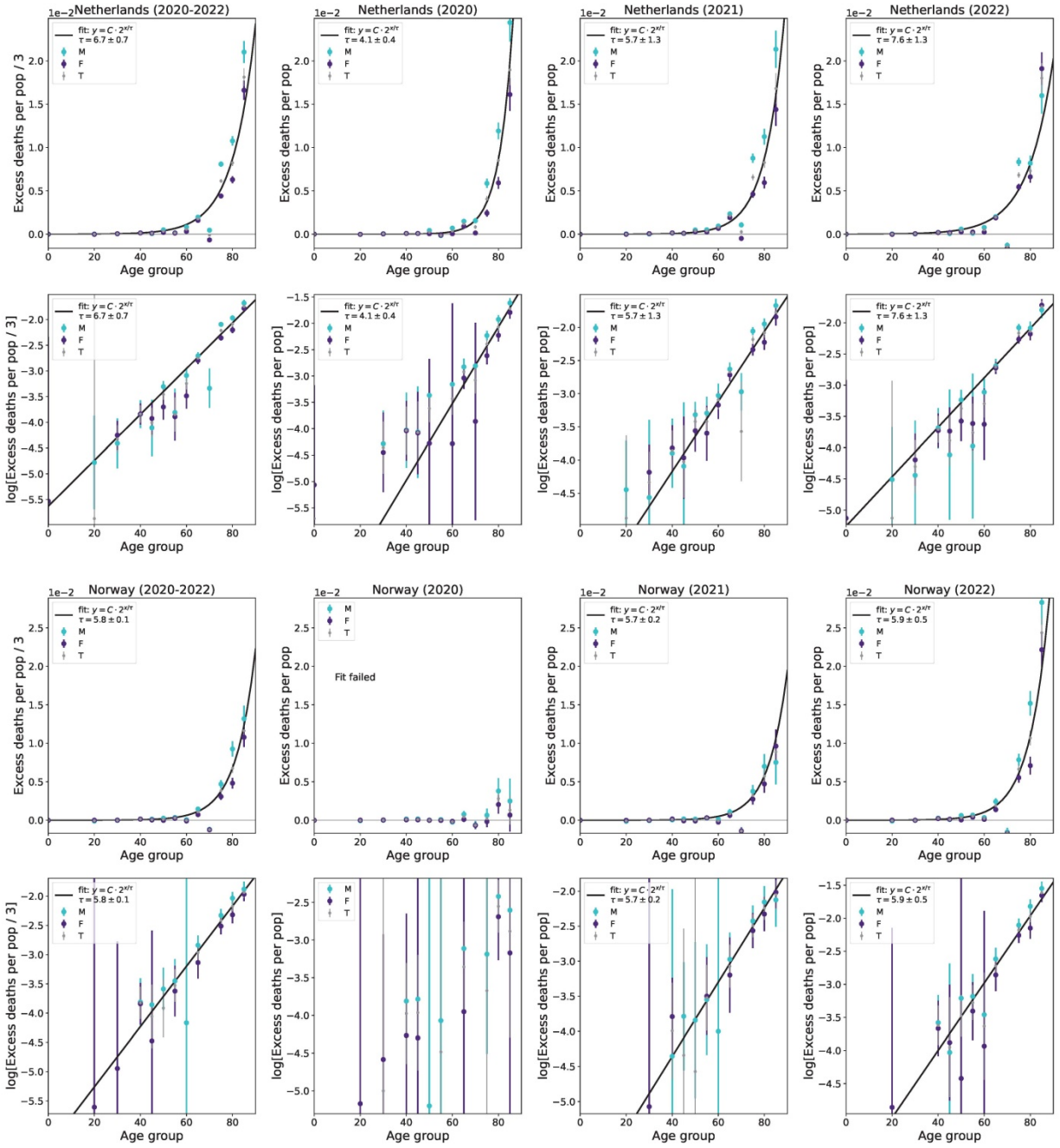


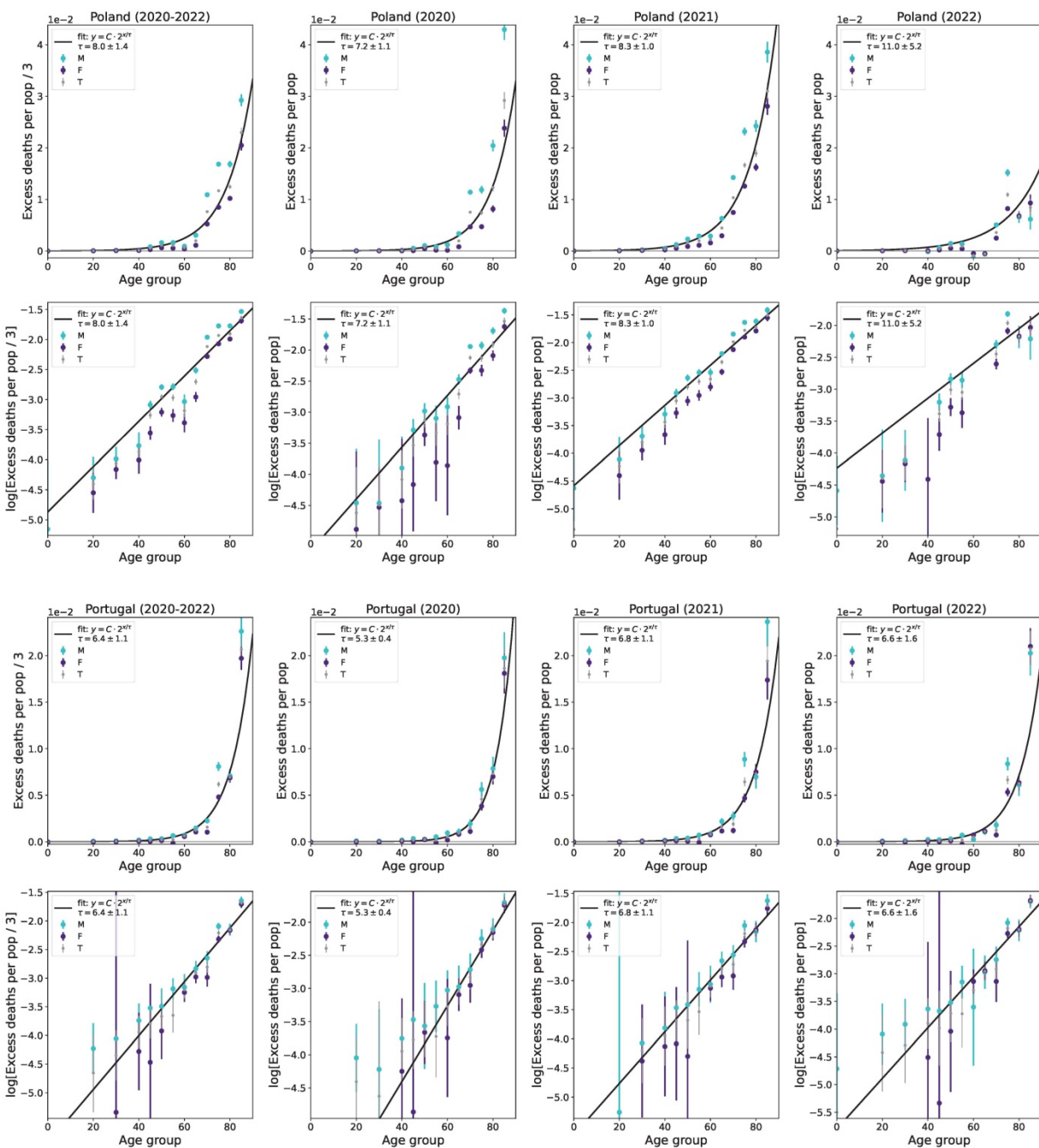


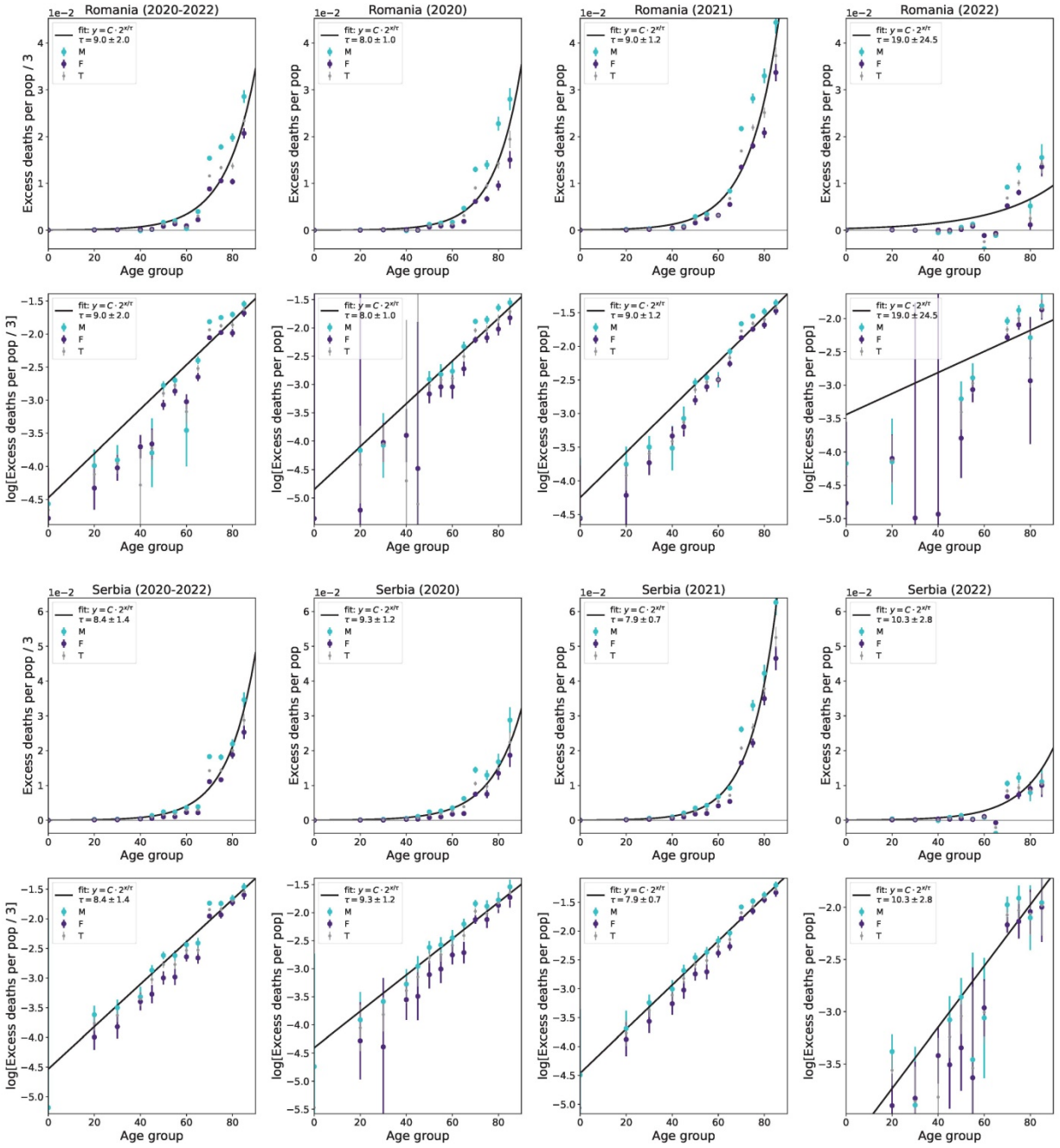


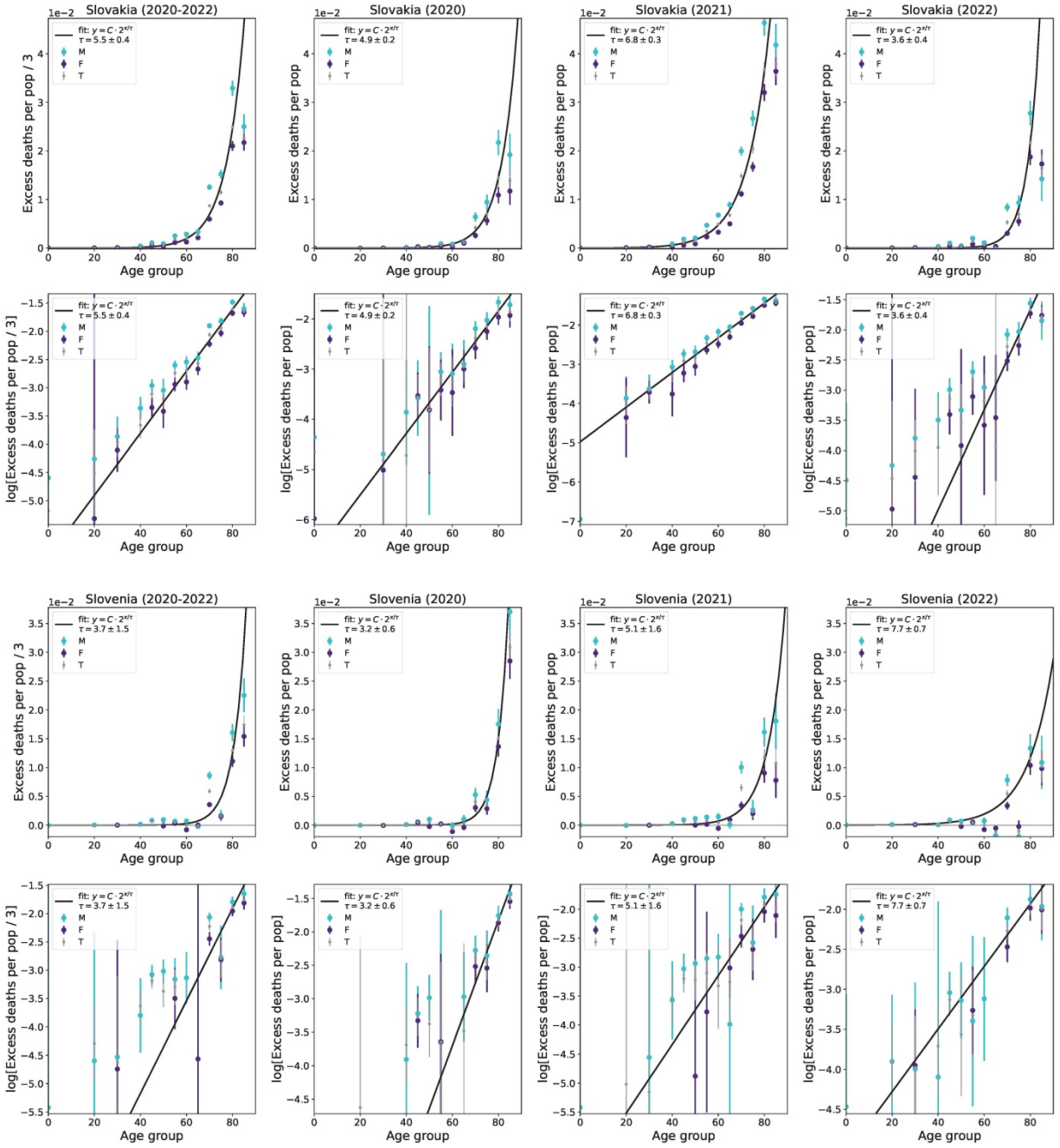


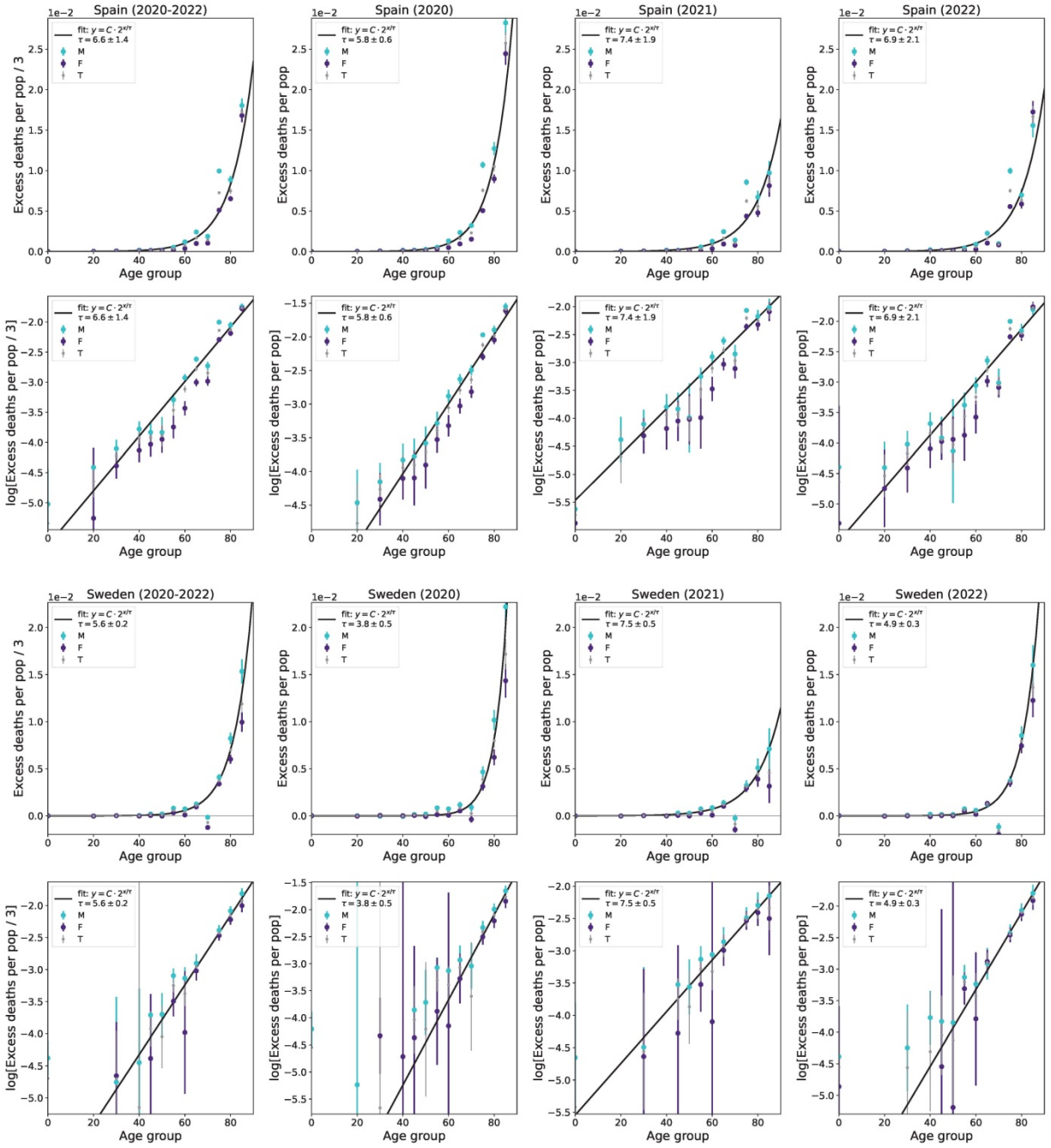












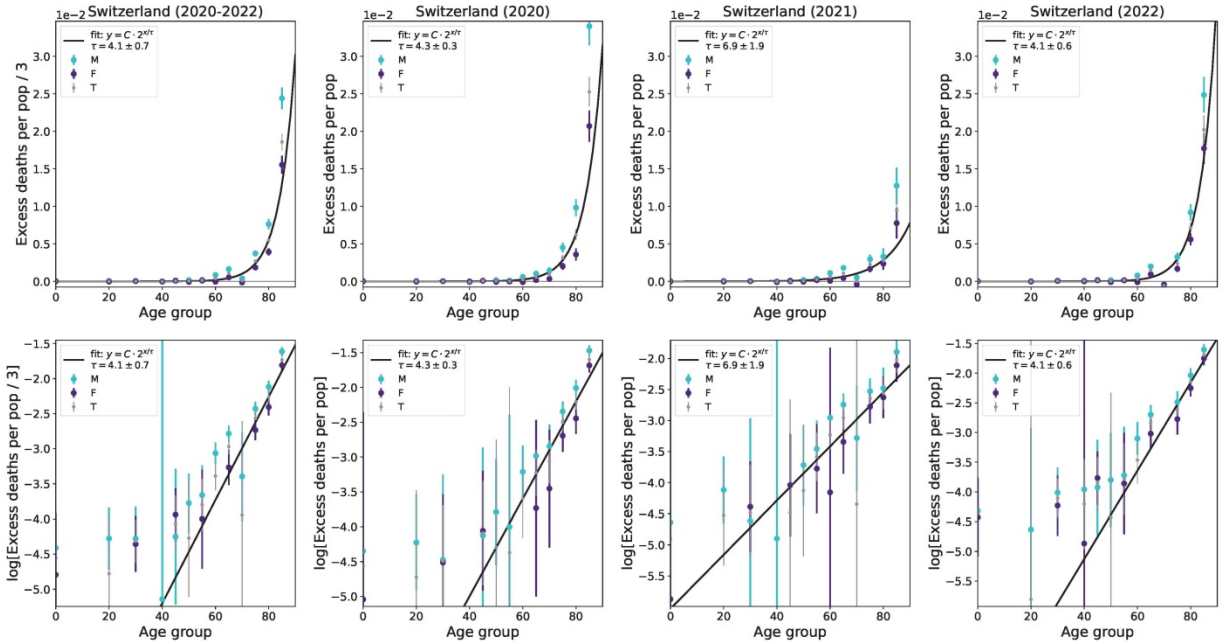


Figure 50. Yearly excess all-cause mortality, by sex, versus age group for 25 European countries (as labelled) for the period 2020-2022 and for the years 2020 through 2022 (as labelled), for both linear (top panels) and logarithmic (bottom panels) excess mortality by population scales. Normalization is by population of the age group and sex in each specific calendar year (January 1 of the year). Exponential fits of the non-sex-discriminated data, over the ten-age-group range 30-39, 40-44 to 80-84 are also shown (black lines), as are the corresponding values of the doubling age τ (in years, with 1σ fitting error).

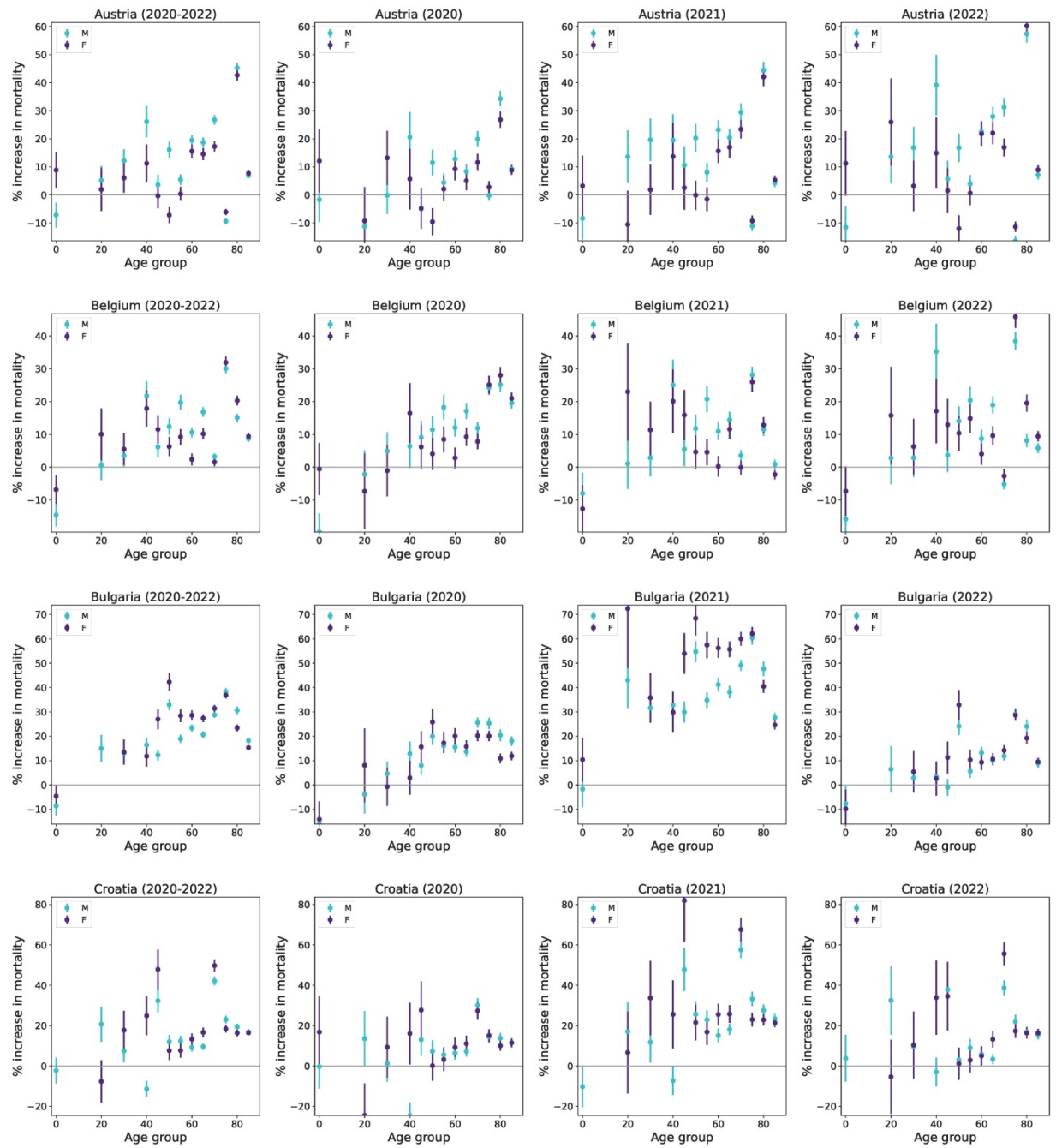
Table 4. Exponential-fit doubling age τ (in years, with 1σ fitting error) in yearly excess all-cause mortality (both sexes) normalized by population (per age group), using the ten age groups 30-39, 40-44 to 80-84 fitting range, by country, for the period 2020-2022 and for the years 2020 through 2022.

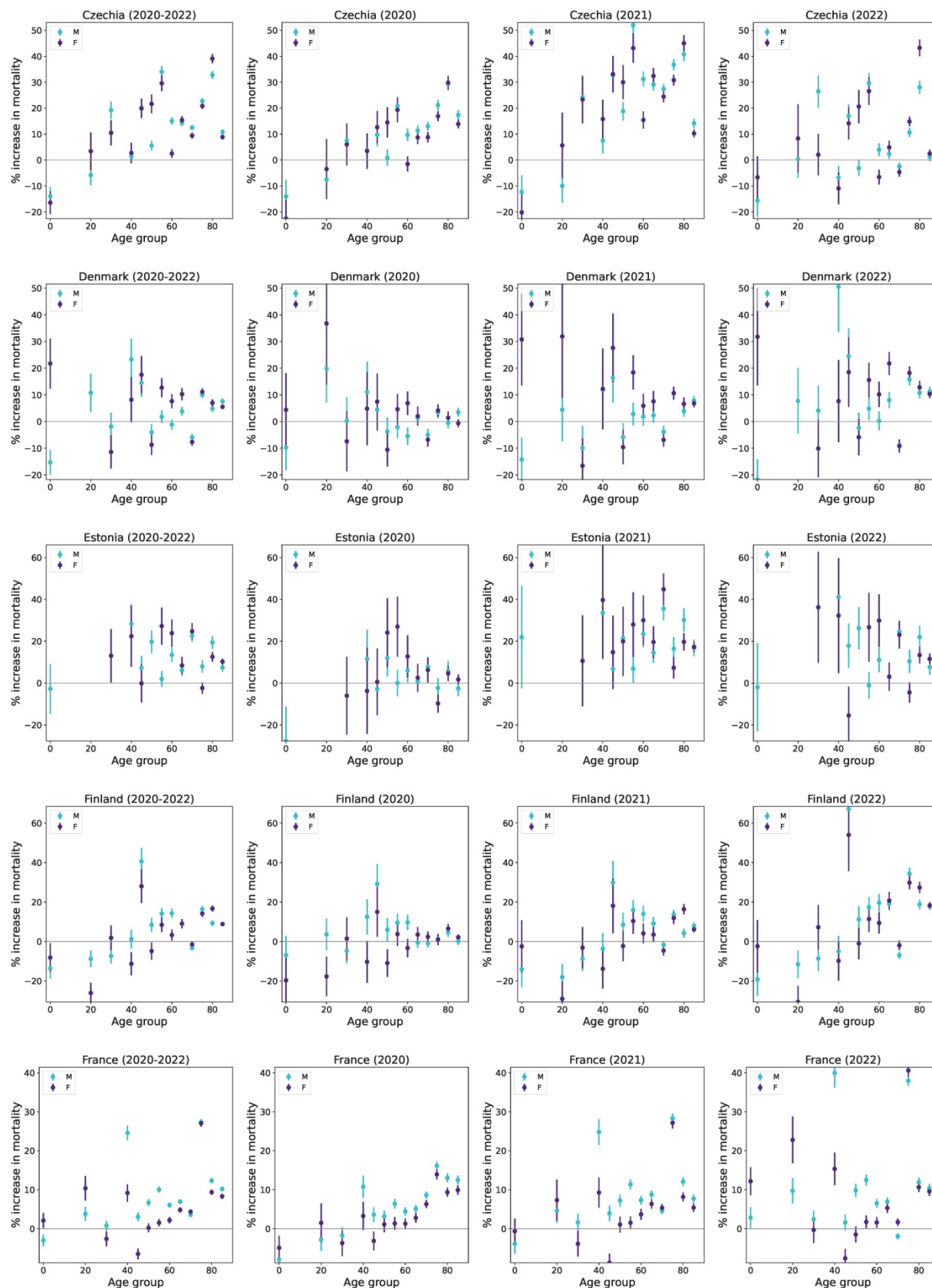
Country	2020-2022	2020	2021	2022
Austria	4.4 (0.1)	nan (nan)	5.0 (0.1)	4.5 (0.2)
Belgium	6.1 (1.6)	4.6 (0.3)	6.9 (2.2)	8.7 (3.0)
Bulgaria	8.1 (0.7)	9.0 (0.9)	8.6 (0.6)	6.1 (0.7)
Croatia	8.3 (1.9)	8.2 (1.8)	8.3 (1.4)	7.3 (1.5)
Czechia	3.9 (0.2)	3.9 (0.2)	5.9 (0.2)	2.5 (0.2)
Denmark	7.9 (2.0)	14.6 (16.2)	8.3 (2.4)	7.2 (1.0)
Estonia	6.8 (2.7)	9.5 (1.9)	8.0 (1.8)	5.2 (2.0)
Finland	6.6 (0.7)	1.7 (0.5)	6.9 (0.6)	7.0 (0.9)

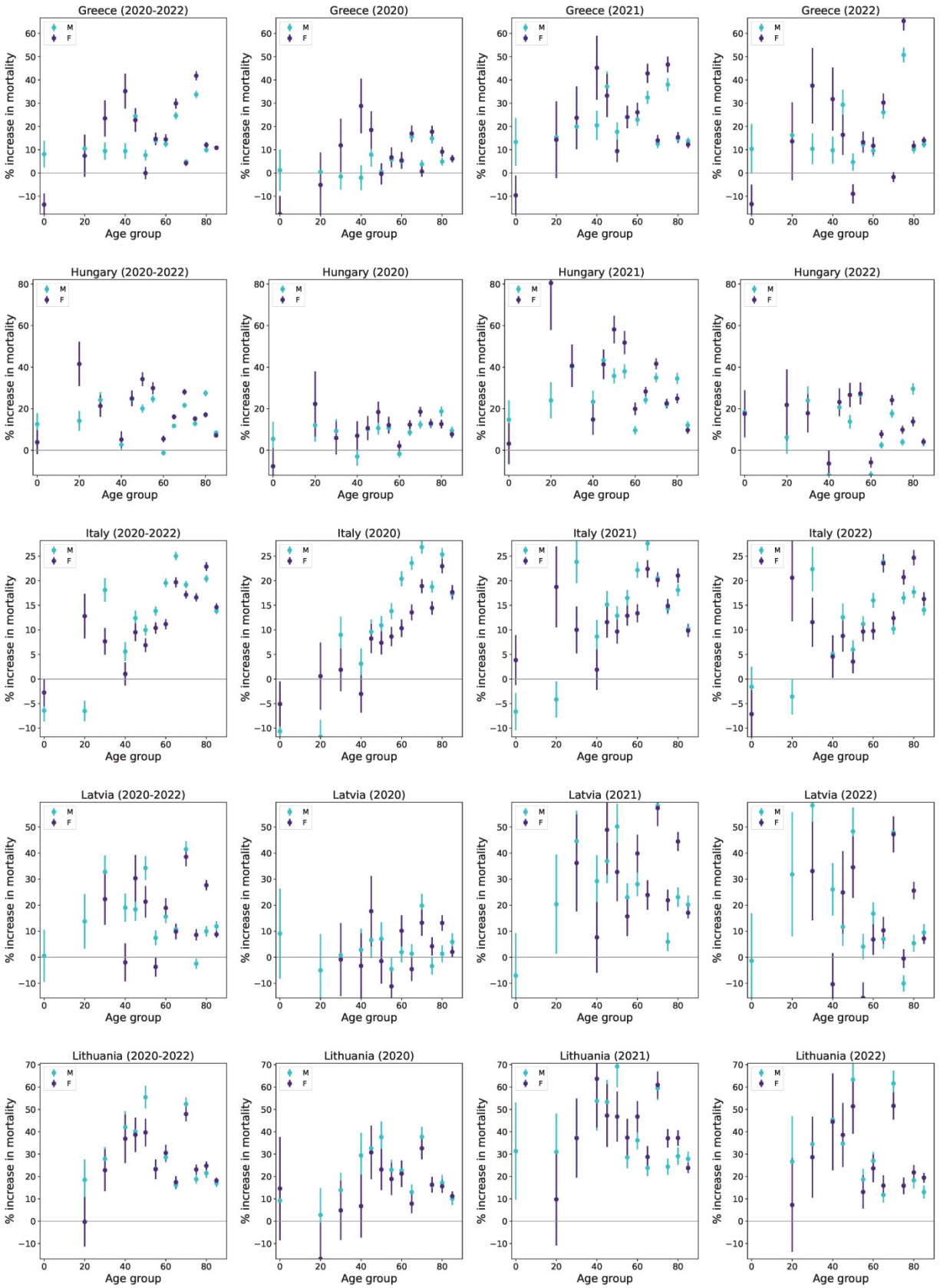
France	7.1 (3.1)	5.9 (0.8)	7.6 (3.4)	8.7 (4.1)
Greece	8.8 (3.4)	7.7 (2.2)	9.4 (2.3)	10.4 (5.3)
Hungary	6.6 (1.0)	6.7 (0.4)	8.4 (1.0)	4.7 (1.4)
Italy	5.3 (0.4)	5.1 (0.4)	6.2 (0.5)	5.0 (0.4)
Latvia	7.9 (3.2)	8.2 (5.2)	8.3 (2.0)	10.6 (3.1)
Lithuania	10.6 (2.0)	11.2 (2.1)	9.7 (1.1)	10.6 (2.7)
Netherlands	6.7 (0.7)	4.1 (0.4)	5.7 (1.3)	7.6 (1.3)
Norway	5.8 (0.1)	nan (nan)	5.7 (0.2)	5.9 (0.5)
Poland	8.0 (1.4)	7.2 (1.1)	8.3 (1.0)	11.0 (5.2)
Portugal	6.4 (1.1)	5.3 (0.4)	6.8 (1.1)	6.6 (1.6)
Romania	9.0 (2.0)	8.0 (1.0)	9.0 (1.2)	19.0 (24.5)
Serbia	8.4 (1.4)	9.3 (1.2)	7.9 (0.7)	10.3 (2.8)
Slovakia	5.5 (0.4)	4.9 (0.2)	6.8 (0.3)	3.6 (0.4)
Slovenia	3.7 (1.5)	3.2 (0.6)	5.1 (1.6)	7.7 (0.7)
Spain	6.6 (1.4)	5.8 (0.6)	7.4 (1.9)	6.9 (2.1)
Sweden	5.6 (0.2)	3.8 (0.5)	7.5 (0.5)	4.9 (0.3)
Switzerland	4.1 (0.7)	4.3 (0.3)	6.9 (1.9)	4.1 (0.6)

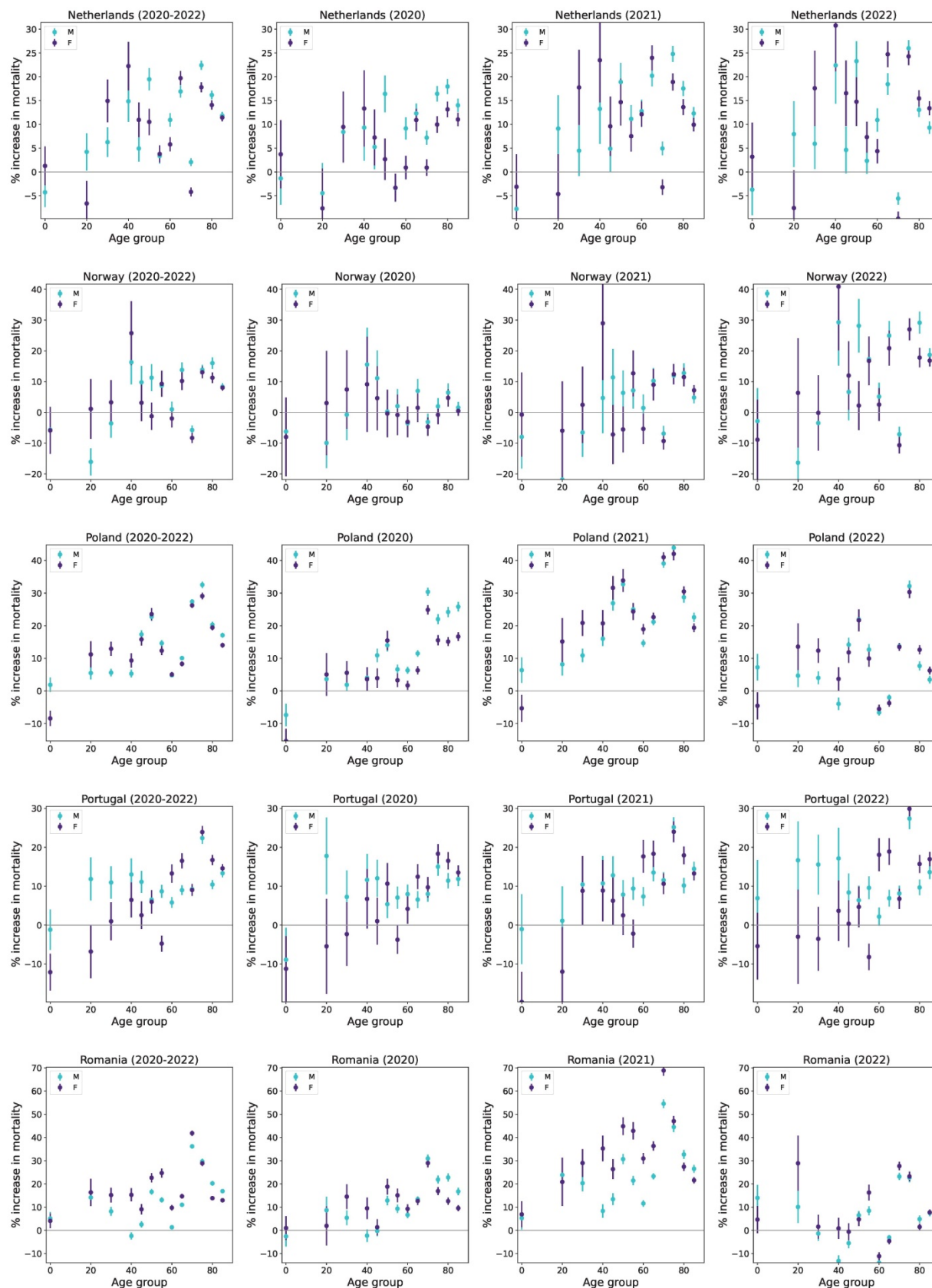
Finally, we examine the age dependence of yearly excess all-cause mortality (see Methods), by sex, for the period 2020-2022 (nominally the Covid period), and for the individual years 2020, 2021 and 2022, normalized by expected all-cause mortality (from the extrapolated pre-Covid historic trend, see Methods) for the same time period or year and for each age group and sex (age and sex-discerned P-score, expressed as a percentage). We use the same thirteen age groups as introduced above: 0-19, 20-29, 30-39, 40-44, 45-49, 50-54, ..., 80-84, and 85+.

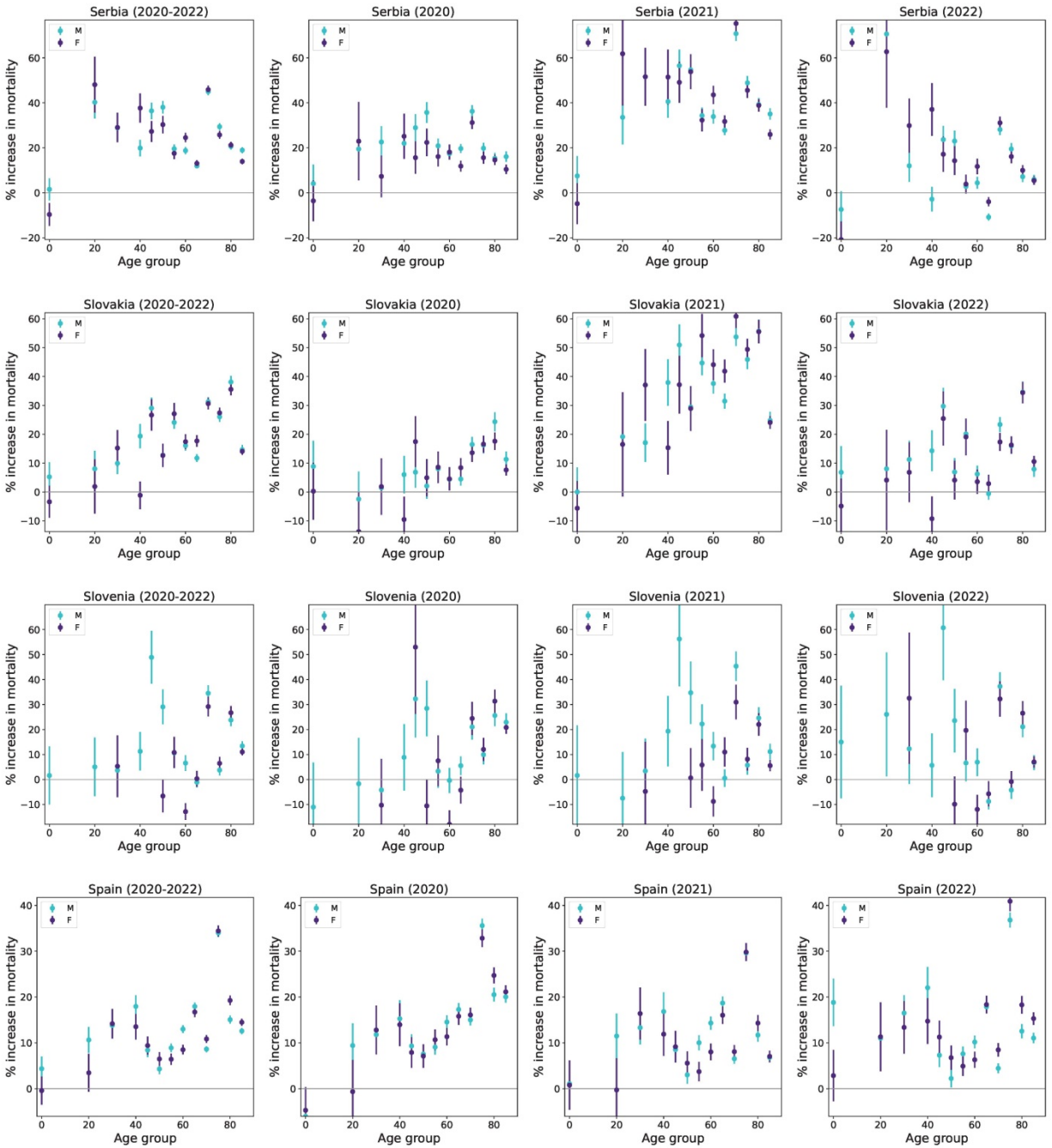
Figure 51 shows yearly excess all-cause mortality, by sex, versus age group for the 25 European countries for the period 2020-2022 and for the years 2020 through 2022, normalized by expected all-cause mortality (from the extrapolated pre-Covid historic trend, see Methods) for the same time period or year and for each age group and sex (age and sex-discerned P-score, expressed as a percentage).











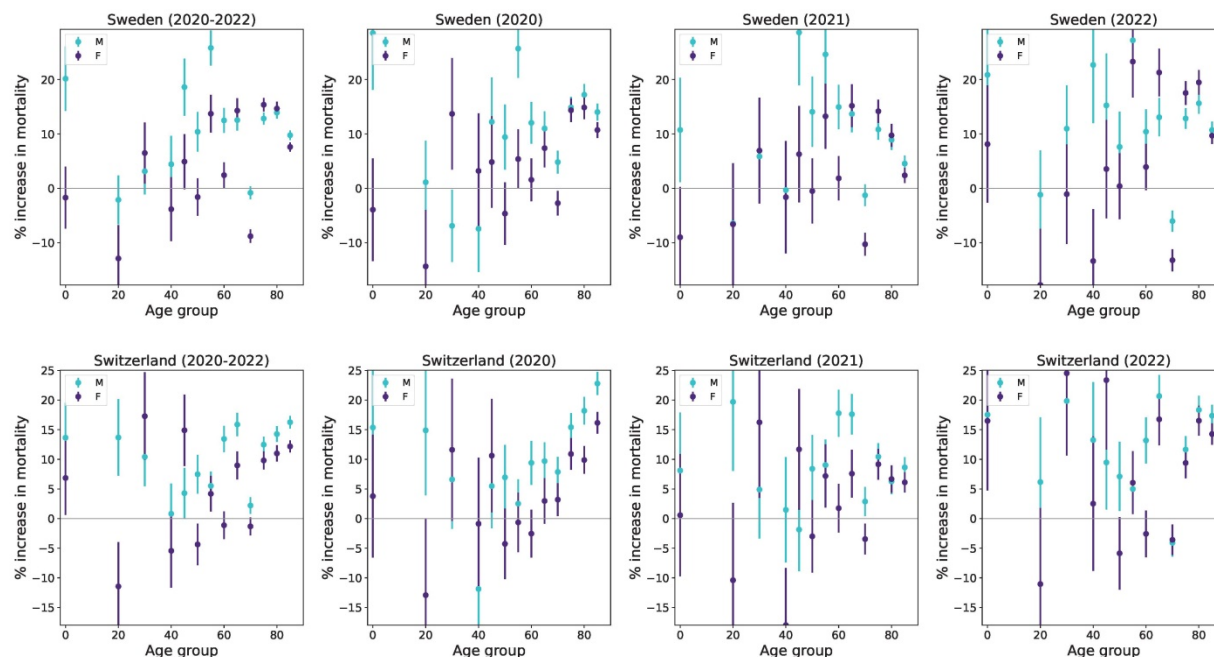


Figure 51. Yearly excess all-cause mortality, by sex, versus age group for 25 European countries (as labelled) for the period 2020-2022 and for the years 2020 through 2022 (as labelled), normalized by expected all-cause mortality (P-score, from the extrapolated pre-Covid historic trend, see Methods) for the same time period or year and for each age group and sex.

Note that, if the doubling ages (τ) on perfectly exponential increases with age were the same for excess and baseline mortalities, then there would be constant values with age of the baseline-normalized excess all-cause mortalities shown in Figure 51, with constant value equal to the ratio of excess to baseline mortalities. The by-country median all-ages value of the said ratio for the 2020-2022 period is 14.1 % (Table 1). Constant values for different age groups are not observed, and the observed variations with age are statistically significant (Figure 51).

5 Discussion

5.1 Limitations in attributing cause of death to vaccine toxicity

The main limitation regarding acquiring a truly global perspective is that weekly or monthly data is not available for China, India, equatorial (most of) Africa, and some large countries such as Indonesia.

Furthermore, whereas all-cause mortality data typically may include information about the age, sex, cultural or racial group, and place of residency or of death of the deceased individuals, it generally excludes all information about prior health status of the deceased individuals, or medical history, or past medical interventions, or COVID-19 vaccination status, or inferred cause of death.

Our hypotheses about the causes of excess all-cause mortality during the Covid period are based on patterns and correlations using available all-cause mortality data (and common available socio-economic variables), and are meant as interpretive guides for further research. Much needed follow-up research would include: extensive and multi-disciplinary field work (including institutional medical protocols and practices, living and social environments, etc.), and in-depth case studies (including autopsies).

Recently, the present authors have contributed to several studies that both: (1) find strong temporal correlations between rapid COVID-19 vaccine rollouts and accompanying sharp peaks in excess all-cause mortality, and (2) quantify corresponding values of risk of death per injection, assuming the deaths are induced by the injections, or would not have otherwise occurred within the time of the associated peak in excess mortality. These temporally correlated peaks in vaccine rollout and mortality are particularly evident in age-stratified mortality and vaccination data, and for the later (booster) doses of the vaccines, or in countries in which there was no excess all-cause mortality prior to the first COVID-19 vaccine rollouts (Rancourt, 2022; Rancourt et al., 2022a, 2023a, 2023b). Many similar temporal correlations between

mortality and vaccine-rollout peaks are seen in the present study, such as in Section 4.6, and with the December-2021-January-2022 peak, or 22-0 peak (Section 4.5, and **Appendix B**).

While it is useful to calculate such a population-wide risk of death per injection, and its age dependence, to appreciate its possible magnitude, it is possible that the observed strong correlations occur due to one or several hidden factors, rather than from a direct causal relationship due to challenge via toxicity of the injected substance.

For example, we might postulate that the teams of attendants who walk into the various institutions housing frail people to administer the latest booster during the period of a rapid rollout, are accompanied by or serve the dual function of a team of attendants who test for positive cases of presumed COVID-19. Each positive test or diagnostic determination, in turn, whether real or false, could have significant negative health consequences for the individual, such as isolation, removal to a different location, confinement, and aggressive chemical and mechanical medical treatment.

It is also possible that the vaccine injections, especially with multiple or booster doses, suddenly induce significant immunosuppression, thus making many vulnerable, frail, and stressed individuals susceptible to infections, including fatal respiratory tract infections, whether predominantly viral or bacterial. Possible mechanisms for COVID-19 vaccine-induced immunosuppression have been suggested (Palmer et al., 2023, ss. 3.3—3.5; Seneff et al., 2022).

To constrain whether or not vaccine toxicity directly causes measurable mortality, versus (for example) the fatal impact of other and concomitant large-scale public health interventions, or versus (for example) vaccine rollouts causing sudden and significant immunosuppression making many vulnerable to fatal respiratory disease, the researcher should have access to vaccine-status-discriminated all-cause mortality data. Such data will constrain more definitively whether the COVID-19 vaccination rollouts have life-saving benefits, or cause additional mortality, and the degree of these

relations. This data is needed for the same countries in which strong temporal associations are present between rapid vaccine rollouts and sharp peaks in excess all-cause mortality.

For any of the three scenarios considered above (vaccine toxicity; concomitant aggressive medical and/or health interventions; vaccine-induced immunosuppression), the systematic medical intervention (injection and/or testing and treatment) would have caused the deaths which otherwise would not have occurred in the relevant short time interval of the sharp mortality peak that follows. In this regard, it is important to keep in mind that the practice of medicine itself has long been authoritatively recognized to be a leading and underestimated cause of death (Makary and Daniel, 2016).

In the Covid context, for example, a study by Rancourt et al. (2021a) showed that there was a large epidemic of fatal bacterial pneumonia in the USA, which apparently was not treated, and the authors proposed that COVID-19-death-assignment was an incorrect cause-assignment for what was in fact bacterial pneumonia. This suggests a Covid-period institutional environment of widespread fatal medical malpractice.

5.2 Magnitude of the excess mortality rate during the Covid period, compared to past mortality events

Before delving into the spatiotemporal and socio-economic variations of excess all-cause mortality during the Covid period, it is useful to calculate and comparatively interpret the average magnitude of the net Covid-period excess all-cause mortality, inferred from the many countries studied.

The total excess all-cause mortality in the period 2020-2022 for the 93 countries having sufficient data is 9.086 million, for a total historic baseline value on the same period of 56.737 million, which gives an excess-to-baseline ratio, for all 93 countries together, of 16.01 %, whereas the by-country median value is 14.1 % (Section 4.9).

As also described in Section 4.9, the excess death rate during the Covid period, treating the 93 countries with mortality data throughout 2020-2022 as one jurisdiction, is 0.3844 ± 0.0021 % of 2019 population. Normalizing to mid-Covid-period 2021 population is achieved by assuming a pro-rata increase based on estimated world populations for 2019 and 2021: $\times (7.888\text{B}/7.742\text{B})$ or $\times 1.019$. This gives an excess death rate for three years (2020-2022) of the Covid period:

$$\begin{aligned}
 &0.3844 \pm 0.0021 \% \times 1.019 \\
 &= \\
 &0.3917 \pm 0.0021 \% \text{ of 2021 population} \\
 &= \\
 &1 \text{ death per } 770 \text{ persons per year during 2020-2022} \\
 &= \\
 &(0.3917 \pm 0.0021 \%) \times 7.888 \text{ billion} = 30.90 \pm 0.17 \text{ million} \\
 &\text{excess deaths globally during 2020-2022}
 \end{aligned}$$

This is for all excess all-cause mortality during the Covid period (2020-2022), or approximately 0.13 % of population per year. The number of COVID-19-assigned deaths is significantly less (Section 4.13).

Here we obtain 30.9 ± 0.2 million projected excess deaths globally for the 3-year period 2020-2022, which is almost twice as many deaths as the 17 million deaths that have previously been projected globally to be associated with the COVID-19 vaccine rollouts (Rancourt et al., 2023a).

For comparison, India (which is not included in the present study) had an April-July 2021 peak in excess all-cause mortality of 3.7 million deaths for its 2021 population of approximately 1.41 billion, which corresponds to an excess death rate of 0.26 % for 2021 alone (and measurably 0 % for 2020, undetected) (Rancourt, 2022; and references therein).

Msemburi et al. (2023), using different methods to account for missing data for large countries, obtained similar numbers for global excess all-cause mortality per population as: 0.06 % in 2020 and 0.13 % in 2021, or 0.19 % for 2020-2021, which can be compared to our 0.39 % for 2020-2022.

Our yearly excess all-cause mortality during the Covid period (0.13 % of population) is less than one tenth of the global average death rate per year of 1.4 % of population, which corresponds to the mean global life expectancy at birth (e_0) of 71 years.

The yearly excess all-cause mortality during the Covid period (0.13 % of population) corresponds to reducing e_0 from the global average of 71 years to approximately 65 years during the three years of the declared pandemic. For the relationship between life expectancy and death rate, see: Liang et al. (2023).

These numbers can be compared to the excess mortality rate during the 1918 pandemic. Arguably the best estimate of the global death toll of the 1918 pandemic is from Spreeuwenberg et al. (2018), and see Roser (2020). The said best estimate is 17.4 million, at a time when the global population was 1.8 billion.

The latter numbers for the 1918 pandemic correspond to a 1918 pandemic death rate, during the course of the pandemic of:

$$\begin{aligned} & 17.4 \text{ million} / 1.8 \text{ billion} \\ & = \\ & 0.97 \% \text{ of population} \end{aligned}$$

which is more than 2 times larger than the excess all-cause mortality death toll per population, for the Covid period (0.39 %, 2020-2022), in the countries studied herein.

Both pandemics (1918 and 2020-2022) were entirely or largely epidemics of bacterial pneumonia, untreated or undertreated with antibiotics, respectively (Rancourt et al.,

2021a; and references therein). Both pandemics (1918 and 2020-2022) had death rates that were highly correlated to socioeconomic status (Mamelund, 2006; Grantz et al., 2016; Mamelund, 2021; Rancourt et al., 2021a, 2022b). Rancourt et al. (2022b) showed proportionality, with a Pearson correlation coefficient of +0.86, between Covid-period excess all-cause mortality by population and share of the population living in poverty, by state in the USA. However, a major difference between the two pandemics (1918 and 2020-2022) is that Covid-period excess all-cause mortality was generally exponential with age (e.g., Section 4.19) whereas excess mortality during the 1918 pandemic in the USA affected primarily young adults, and did not produce excess all-cause mortality for those aged 50+ (Rancourt et al., 2021a). Bailey et al. (2024) argue that the high mortality rate of young (mostly male) adults is due to surviving the horrendous war conditions of the First World War (waged in Europe, Africa, Middle East, Asia, Pacific Ocean, Pacific Islands), which ended on 11 November 1918.

The two pandemics (1918 and 2020-2022) have comparable death rates by population (0.97 % and 0.39 %, respectively) but both have death rates that do not approach the large death rate of the Black Death (bubonic plague) pandemic of 1347-1352, which had high selectivity on health status or frailty (DeWitte and Wood, 2008), and which is documented to having been associated with the loss of some 30-50 % of the European population, in a historic period and environment when average human life expectancy at birth was barely more than 30 years, and in which the leading cause of death generally was infections (Finch, 2009).

5.3 Large-scale jurisdictional, spatial and temporal variations of Covid-period excess all-cause mortality

The Results show much complexity apparent in the spatial and temporal variations of excess all-cause mortality in the world (125 countries) during the Covid period (2020-2023).

For the countries with available data in the present study, we have the following large-scale behaviour of excess all-cause mortality by country:

- Large country to country variability in excess all-cause mortality during the Covid period (**Appendix A**, **Appendix B**, Figure 16, **Appendix D**, Table 1, and also Figure 1, Figure 2, etc.), including both intra-continent and inter-continent variability
- Large temporal variations in excess all-cause mortality during the Covid period, in each individual country (**Appendix A**, **Appendix B**, Figure 16, **Appendix D**, Table 1, and also Figure 1, Figure 2, etc.)
- Three large clusters of countries (cluster analysis, with countries having populations greater than 1 million) having similar yearly-resolved temporal patterns of all-cause mortality (2019-2022), which largely group geographically (Figure 12, Figure 13)
- The mostly geographically grouped clusters of countries (cluster analysis, with countries having populations greater than 1 million) have distinct temporal variations of their distributions of values of excess all-cause mortality, as characterized by the statistical parameters of mean, median, standard deviation, and coefficient of variation ($cv = \text{standard deviation} / \text{mean}$) (Figure 17)
- Correspondingly, continental-scale groupings of countries have similar excess all-cause mortality magnitudes and temporal patterns (e.g., Eastern Europe with Russia and Northern Asia) (Figure 17, Figure 18, Figure 19, Figure 21)
- Large spatial gradients of excess all-cause mortality, across countries and between countries sharing large land borders, such as: east-west in Europe and north-south in North America (Figure 3, Figure 4, Figure 18, Figure 19, Figure 21)
- Spatially heterogeneous (country to country) large temporal peaks in excess all-cause mortality nominally occurring March-April 2020 (20-3 feature), October-November 2020 (20-10 feature), December-2021-January-2022 (22-0 feature), December-2022-January-2023 (23-0 feature) (Sections 4.2, 4.3, 4.4, 4.5, and Figure 5, Figure 6)
- Absence of excess all-cause mortality, up to a late and sharp massive peak in excess all-cause mortality, often synchronous with a vaccine rollout, in mostly

island and small coastal countries (also seen with India, Rancourt, 2022)
(Section 4.6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11)

- Thirty two (32) of the 76 countries allowing reliable quantification have a high statistical certainty of having persistent and significant excess all-cause mortality in the available data for 2023, up to June 2023 and excluding excess mortality from peak residuals extending out from any 23-0 feature (by selecting an integration start date a few weeks or more later than 1 January 2023), notably after the 5 May 2023 WHO declaration of an end of a pandemic (Section 4.8, Figure 14, Figure 15)

Notably, the large geographical and temporal variations in excess all-cause mortality (normalized either by population or by historic baseline all-cause mortality) are systematically different for the three clusters identified in Section 4.7. This is shown in Figure 17, which has the mean, median, standard deviation, and coefficient of variation ($cv = \text{standard deviation} / \text{mean}$) values of the excess all-cause mortality (normalized either by population or by historic baseline all-cause mortality) for all countries (blue) in the present study and for countries in each of the identified clusters of countries (Section 4.7: cluster 1, orange; cluster 2, green; cluster 3, red; no cluster, black, population ≤ 1 million, or data ends prior to end of 2022), and for each of several different time periods of integration (2020-2022, 2020-2023-H1, and each half year 2020-H1 through 2023-H1).

5.4 East-West divide in Europe

Our analysis shows a large distinction regarding excess all-cause mortality between Western European countries and Eastern European countries including Russia, with Eastern European nations having significantly larger Covid-period mortality, and among the largest in the world.

The said large East-West distinction in excess all-cause mortality is strikingly captured in the cluster analysis (Section 4.7, Figure 13; Figure 17) and in the maps of spatial distribution of excess all-cause mortality (Section 4.11, Figure 18, Figure 19).

The structure of the excess all-cause mortality by time (week or month) is also distinctly different for Eastern and Western European countries (**Appendix A**). Western European countries can have large March-April 2020 peaks (20-3 feature, Section 4.2) whereas Eastern European countries do not. In addition, Eastern European countries typically have remarkably large October-November 2020 peaks (20-10 feature, Section 4.3) whereas Western European countries do not.

We would not accept the hypothesis that more virulent strains or variants of the presumed SARS-CoV-2 virus were acting in Eastern Europe than in Western Europe, and in different time periods. The gymnastics needed to advance such a hypothesis would be too strenuous.

Rather, we would propose the following observations to help explain the large difference in magnitude of excess all-cause mortality (rate or P-score) between Eastern European and Western European countries.

We hypothesize that the relatively high excess mortality in Eastern European countries is due to a large share of the population aged 60+ corresponding to former workers who lost their economic and employment security after the dissolution of the Soviet Union in the early 1990s, and who presently live in poverty with low social status. This is supported by the strong correlation that exists between excess mortality rate and the product of share of population aged 60+ and share of population living with < \$30/day (Section 4.18, Figure 48, Table 2). It is also evident in world maps of such socio-economic factors as life expectancy at 65 and share of population living with < \$30/day (Section 4.11, Figure 20). See Section 5.12.

Our hypothesis is further supported by world maps of post-early-1990s prevalence of tuberculosis by country (Dye et al., 1999, their Figure 1; Glaziou et al., 2015, their Figure 1). See Section 5.12.

Similarly, Bonnet et al. (2024) reported the same excess all-cause mortality East-West disparity in Europe, and tentatively interpreted it this way:

“This outcome is in line with the results of a recent study³³, who concluded that the East-West differences in excess mortality are related to structural and psychosocial traits that have their roots in the communist era. On the one hand, this includes differences in the connectivity of populations, driving the later onset of the pandemic in the East (from October 2020 onwards), while the West was hit more in the first wave (March to May 2020). On the other hand, this likely includes profound disparities in levels of vulnerability to the disadvantage of the East, e.g. in terms of pre-existing diseases, intensified by lagging economic development and selective migration due to their impact on risk-relevant behaviour. Lower levels of compliance with policy interventions (e.g. social distancing and vaccination) and a generally lower level of trust in authorities might also stem from the communist past of CEE countries.”.

We disagree with the notion advanced by Bonnet et al. (2024) and the authors they cite that excess mortality in the Eastern European countries is delayed 1st wave mortality compared to the Western countries (20-3 versus 20-10 features) because of differences in interpersonal contacts between the two types of societies. We argue that all-cause mortality disproves the notion of spread (Section 5.6). If anything, we would argue that “lower levels of compliance with policy interventions” and “a generally lower level of trust in authorities” may have saved Eastern Europeans from the “1st wave” March-April 2020 peak in excess mortality (20-3 feature) that we take to be due to aggressive institutional response (fatal treatment in hospitals and care facilities) (see below: Sections 5.12.2 and 5.12.3.2).

5.5 Exceedingly large country-to-country heterogeneity of excess all-cause mortality

The time-period-specific excess all-cause mortality described above gives an inescapable result:

- The country-to-country differences are remarkably large (Figure 16, **Appendix D**, Table 1, Figure 17, Figure 18, Figure 19, Figure 21, **Appendix E**).

For example, this is reflected in values of the coefficient of variation ($cv = \text{standard deviation} / \text{mean}$) for different time periods, presented in Table 1 and shown in Figure 17, which are the order of 1 and can be as large as 3 or more.

This is true not only with population-normalized excess mortality, but also with excess mortality normalized by the expected (historic trend) mortality (Table 1, Figure 17), which takes into account country-to-country age structure and health status differences.

A good example is the integrated excess all-cause mortality for the first half-year of 2020 (2020-H1 period), during which a pandemic was declared by the WHO on 11 March 2020. The prominent 20-3 feature (March-April 2020 peak in excess all-cause mortality) occurs in this period, but only in relatively few countries. The 2020-H1 panel in Figure 16 shows that the great majority of countries had zero or near-zero excess all-cause mortality in this half-year, in which the median value is 0.7 % of expected mortality. Relatively few outlier countries had large (and essentially synchronous) 20-3-type excess mortality peaks (**Appendix A**), and the resulting coefficient of variation is 3.0, which is extraordinarily large, and it is even much larger in cluster 2 (green cluster, $cv > 70$, due to a small value of the mean) and cluster 3 (red cluster, $cv > 8$) (Figure 17).

In June 2020, Rancourt (2020) argued — based largely on early data from USA states — that the synchronous and heterogeneously distributed 20-3 feature (March-April 2020 peak) was incompatible with a viral respiratory pandemic and instead was due to

iatrogenic deaths in vulnerable groups. The main elements of Rancourt's argument are confirmed in the present study based on 125 countries.

The same kind of large inter-country variability in excess all-cause mortality occurs with a period of integration in time over essentially the entire Covid period, 2020-2022. Here (Table 1), the coefficient of variation is 0.55 ($cv = \text{standard deviation} / \text{mean} = 8.1 \% / 14.7 \% = 0.55$) — with excess mortality normalized by the expected (historic trend) mortality, which takes into account country-to-country age structure and health status differences. And see Figure 17.

In other words:

- The country-to-country ($N = 93$, Table 1) 2σ range in excess all-cause mortality for essentially the entire Covid period (2020-2022) spans values between approximately 0 % and 31 % of the extrapolated historic trend all-cause mortality.
- That is, the excess all-cause mortality expressed as a P-score for the 2020-2022 Covid period spans values between approximately 0 % and 31 %.

This (0-31 %) is an outstandingly large country-to-country variability; for example, compared to the historic record of large but robustly constant seasonal variations in all-cause mortality (**Appendix A, Appendix B**).

We stress that the above described large heterogeneity in country-to-country excess all-cause mortality normalized by the expected historic trend mortality (P-score, which takes into account country-to-country age structure and health status differences), using several different integration time periods ($N \leq 125$, Table 1) is incompatible with a pandemic model in which a new virulent and contagious pathogen causes the increased mortality:

- The pandemic model would require the pathogen to carry a passport and to unnaturally change its virulence in attacking vulnerable populations in different national jurisdictions.

- Since the observed variability is by national jurisdiction, it seems more plausible to us that the largely varying mortality rates are due to different institutional treatments and societal assaults against vulnerable groups in the different countries, and to country-specific vulnerabilities that are not accounted for by normalization using historic trend mortality.
- The correlations with socio-economic variables reported above and discussed below support this hypothesis.

5.6 Absence of spread across national boundaries

In addition to the above-described country-to-country heterogeneity in normalized excess all-cause mortality, another striking feature is that large normalized excess all-cause mortality often does not cross national boundaries into directly neighboring countries, for extended periods of time.

In other words, continental and subcontinental-scale geographical patterns and gradients of large national differences in normalized excess all-cause mortality do not attenuate or homogenize for many months and years, contrary to the hypothesis of human-contact-mediated spreading of the cause of excess mortality.

For example, the large north-to-south Canada-USA-Mexico gradient of increasing normalized excess all-cause mortality, seen for time-period integration over the entire Covid period (2020-2022) (Figure 19), is maintained in every half year from 2020-H2 through 2021-H2 (Figure 21). Only as the magnitude of excess mortality winds down globally does this gradient attenuate into 2022 (Figure 21).

Another example is the case of Germany, wherein Germany has low normalized excess all-cause mortality, while being adjacent to and surrounded by countries with relatively high relative mortalities, during the period 2020-H1 through 2021-H1 (Figure 21).

A further illustration is provided by the east-to-west brochette of border-sharing countries Portugal-Spain-France-Germany-Poland, which has dramatically different all-cause mortality versus time curves during the Covid period, not in any sequence consistent with human-contact-mediated spreading of the cause of excess mortality (Figure 4). In particular the large 20-3 March-April 2020 feature in Spain is accompanied by a synchronous weaker such peak in France and does not give rise to delayed similar features in neighbouring countries, which would be expected in a spread hypothesis (Figure 3, Figure 4).

An absence of all-cause mortality spread is also apparent in several similar USA states that share land borders, in which differences are associated with lockdown policies (Johnson and Rancourt, 2022).

On a larger geographical scale than simply neighbouring countries, it is remarkable that the three large groups of populous (> 1 million) countries identified in the cluster analysis performed using not-normalized yearly raw all-cause mortality for the years 2019-2022 (Section 4.7) have distinct normalized excess all-cause mortality temporal behaviours (Figure 13, Figure 17, Figure 19, Figure 21). This is clear in Figure 17 and, if the risk of death were primarily determined by viral properties, would require that three different pathogens (with different contagiousness and virulence) would have separately infected three groups of countries in the present study, dividing the world into three, not to mention the puzzling and distinctive excess all-cause mortality patterns that occur in island nations (Section 4.6).

Our conclusion that the country-to-country heterogeneity of excess all-cause mortality (Section 5.5) and absence of spread of high excess all-cause mortality across national boundaries (this section) are incompatible with a pandemic model in which a new virulent and contagious pathogen causes the increased mortality is supported by higher spatial resolution data for the USA and Europe (not shown), and by further considerations described below.

5.7 Comparison of excess all-cause mortality and infection fatality rate (IFR) determinations

Infection fatality rate (IFR) determinations are problematic because they are often accepted at face value rather than being fundamentally questioned. The IFR is an operational parameter defined to be the number of deaths from the presumed specific pathogen divided by the number of infections with the pathogen, occurring in a given population, over a sufficiently long time period.

The number of infections is ascertained using seroprevalence determinations, which use blood tests to detect post-infection residual antibodies presumed to be specific for the presumed pathogen. Even reviews that describe the many challenges and uncertainties in performing seroprevalence determinations (McConnell et al., 2021) do not question whether the molecular antibody test itself is specific or has been reliably validated, which is often not the case with new commercial tests (e.g., Rancourt, 2021).

This means that there is a large uncertainty in the denominator of the IFR.

The numerator of the IFR, in this context, is the number of counted COVID-19-assigned deaths. However, there are also large uncertainties with PCR testing for SARS-CoV-2 (Borger et al., 2020), and cause-of-death assignation is itself prone to bias, with and without laboratory testing.

Nonetheless, if we take current IFR determinations for SARS-CoV-2 during the Covid period essentially at face value, as do the authors of the following studies, then:

- Ioannidis (2021) in a review estimated a global whole-population (all ages) IFR to be 0.15 %, typical values of IFR for Europe and the Americas to be 0.3–0.4 %, a global number of infections to be 1.5–2.0 billion by February 2021, and noted “substantial differences in IFR and in infection spread across continents, countries and locations”.

- COVID-19 Forecasting Team (2022) in a systematic analysis found all-country whole-population (all ages) median values of IFR to be 0.466 % (0.223–0.840, interquartile range) on 15 April 2020, 0.314 % (0.143–0.551) on 1 January 2021, and noted “substantial heterogeneity in the IFR by age, location, and time ... IFRs varied by a factor of more than 30 among 190 countries and territories in this analysis”.
- Pezullo et al. (2023) in a systematic review for 29 countries found median IFR values of 0.034 % (0.013–0.056) for ages < 60, 0.095 % (0.036–0.119) for ages < 70, 0.506 % for ages 60-69, their Figure 1 showing large country-to-country differences, and an exponential increase with age with quadrupling of IFR for every 10 years in age.

Whereas these reported values of IFR have magnitudes and heterogeneity consistent with our values of excess all-cause mortality by population (assuming that most excess-mortality deaths were COVID-19 deaths and that most of the populations were infected with SARS-CoV-2), this does not constitute support for the hypothesis that the excess mortality was due to a presumed new and virulent virus.

The reason is twofold:

- First, the reported heterogeneities in IFR may be largely due to the above mentioned inescapable uncertainties in IFR determinations, which cannot easily be deconvoluted from any actual heterogeneity.
- Second, the said “consistency” (of having heterogeneity) would arise with any cause of excess mortality, if the deaths are assigned to COVID-19 and if seroprevalence estimates suggest that most of the population was infected, irrespective of whether most excess mortality is associated with respiratory conditions.

More importantly, and this is not directly addressed by the above named authors of reviews of seroprevalence studies and IFR estimations, the large spatiotemporal heterogeneities in inferred IFR values, if real — like the large spatiotemporal

heterogeneities in excess all-cause mortality normalized by population or by historic baseline mortality, which are real (Figure 16, **Appendix D**, Table 1, Figure 18, Figure 19, Figure 21, **Appendix E**) — are incompatible with an interpretation in which the excess deaths are caused by a distinct virulent pathogen.

The whole idea of an IFR is that it is characteristic of a specific presumed virulent pathogen. The pathogen hypothesis becomes nonsensical if the resulting death rate is essentially determined by presumed or unknown local population and environmental characteristics, in order to explain a large range of seemingly random values of IFR.

In other words, if degree (population share) of inferred exposure to the presumed pathogen (seroprevalence) is not a predictor of excess mortality (if IFR is virtually random in this regard), then what is the pathogen? If the main predictors of (age and frailty adjusted, historic baseline normalized, P-score) excess mortality are moderate poverty, type of government and historical circumstances (Sections 4.11, 4.12, 4.15, 4.18, 5.3, 5.5, 5.6), then how can the presumed specific new and globally prevalent pathogen be considered “virulent” whatsoever?

5.8 Correlations of excess all-cause mortality and socio-economic variables by country

The large country-to-country heterogeneity in normalized excess all-cause mortality (Section 4.9, Section 5.5) compels one to look for correlations with national variables or factors that are expected to be valid socio-economic indicators, and suggests that correlations should be detectable.

Recently, Ioannidis et al. (2023) have done this — for 34 countries, with fewer tested variables and using relatively inaccurate quantification of excess all-cause mortality — and found statistically significant differences between countries grouped as less and more vulnerable, with the latter defined as having “per capita nominal GDP < \$30,000, Gini > 0.35 for income inequality and/or at least $\geq 2.5\%$ of their population living in

poverty”. For comparison and completeness, in **Appendix J** we show a recalculation for the 34 countries studied by Ioannidis et al. (2023) using our excess mortality analysis method, add the countries from the present study not included by Ioannidis et al., and apply their same “less and more vulnerable” country categorization to all the available countries. Their conclusions are valid despite the systematic error and the smaller selection of countries.

In the present study, continental and subcontinental spatial patterns and large spatial gradients of normalized excess all-cause mortality in themselves (Section 4.11, Section 5.3) directly show significant correlations with poverty or socio-economic and politico-cultural factors, such as the north-south Canada-USA-Mexico gradient in North America and the east-west Western European to Eastern European gradient in Europe and into Asia, which are persistent in time (Figure 18, Figure 19, Figure 21; and compare to Figure 20).

In addition, as discussed above, there is a global-scale clustering of countries, with cluster-analysis country groups having significantly different mortality behaviours, which is apparently tied to underlying socio-economic, historic and political differences (Section 4.7, Section 4.10, Section 4.11), again suggesting the potential for correlations with factors other than pathogen characteristics.

Therefore, we explored and quantified correlations between excess all-cause mortality (on different given time periods, normalized either by population or by expected all-cause mortality from the extrapolated pre-Covid historic trend for the same time period) with several socio-economic variables, and their products (Sections 4.11, 4.15, 4.16, and 4.18, and appendixes referenced therein).

We remind the reader that when excess mortality on a given time period is expressed as a percentage of (or normalized by) expected all-cause mortality from the extrapolated pre-Covid historic trend for the same time period (i.e., as a “P-score”) it is measured in comparison to the intrinsic baseline mortality rate (by time period) in the

society or jurisdiction. The latter baseline mortality is a weighted average of all the country-specific factors affecting baseline (pre-Covid) mortality, such as age structure and health frailty or vulnerability. Thus-normalized excess all-cause mortality therefore is an age structure- and health status-adjusted specific national mortality.

If we prefer to measure the excess mortality directly on a per population basis, irrespective of the health status and age structure of the population, then we express the excess all-cause mortality as a fraction of a recent census population. We use census year 2019. The thus normalized excess all-cause mortality is highly dependent on and reflects age structure and societal health frailty.

The results (scatter plots and their analyses) were organized as follows (Section 4.15, Section 4.16):

- The excess all-cause mortality was normalized either by expected (historic baseline) all-cause mortality (Section 4.15) or by population (Section 4.16). (x2 outcomes)
- Each normalized excess all-cause mortality was calculated on eight or more different time periods (2020-2022, and each half year from 2020-H1 through 2023-H1; and sometimes additionally 2020-2023-H1 and calendar years 2020, 2021 and 2022). (x8 or more outcomes)
- A subset of eight socio-economic variables was selected for illustration of scatter plots with single (non-product) variables (x8 single variables):
 - i. GDP per capita (Figure 26, Figure 34)
 - ii. Gini inequality coefficient (Figure 27, Figure 35)
 - iii. share of population living on \leq \$5/day-person (Figure 28, Figure 36)
 - iv. share of population living on \leq \$30/day-person (Figure 29, Figure 37)
 - v. income per day (Figure 30, Figure 38)
 - vi. life expectancy at age 65 (Figure 31, Figure 39)
 - vii. share of population aged 60+ (Figure 32, Figure 40)
 - viii. share of population aged 90+ (Figure 33, Figure 41)

- Here, each of the resulting $2 \times 8 \times 8 = 128$ or more scatter plots illustrated use points (with error bars, and labelled by country code) in four different colours, for the three clusters identified by cluster analysis and those countries not assigned to clusters (population < 1 million, or data ends before the end of 2022) (see Section 4.7).

Associated scatter plots and corresponding tables of Pearson correlation coefficients are:

- **Appendix F:** Scatter plots of relations between socio-economic variables
- **Appendix G:** Table of Pearson correlation coefficients between socio-economic variables
- **Appendix H:** Table of Pearson correlation coefficients between all-cause mortality, excess all-cause mortality (both normalizations) and socio-economic variables

Of the eight selected socio-economic variables listed above, two consistently have the largest Pearson correlation coefficient magnitudes ($|r|$), for the periods and half-years of the Covid period. These are: (iv) “share of population living on $\leq \$30/\text{day-person}$ ”, and (v) “income per day” (median income or expenditure per day).

Regarding excess all-cause mortality as percentage of the expected (extrapolated historic trend) all-cause mortality (P-score), these correlation coefficient values are typically $r(\leq \$30/d) \sim +0.5$ to $+0.6$ and $r(\text{income}) \sim -0.5$ to -0.6 , which is “moderate” to “strong” (Evans, 1996). Strangely, these correlations change sign in the half-years 2022-H2 and 2023-H1, relative to the earlier periods. The situation is similar with excess all-cause mortality by population. (**Appendix H**)

Thus, as Rancourt et al. (2022b) found for the states of the USA (their Figure 20, $r = +0.86$, and see Rancourt et al., 2021a), poverty is the dominant single factor that correlates to excess mortality during the Covid period. This is generally true across the

125 countries providing data, specific short-time-period anomalies notwithstanding (**Appendix H**).

In virtually every country studied, people living in poverty died predominantly in excess compared to the pre-Covid-period historic record. This result holds in taking into account age structure and baseline frailty (P-score), and is even stronger than with purely population normalization (**Appendix H**).

Indeed, even though bulk yearly all-cause mortality rate itself (total yearly all-cause mortality divided by population) correlates strongly with age structure (i.e.: “share of population aged 60+”, $r \sim +0.75$ to $+0.80$, years 2015-2022, see **Appendix H**), as expected from the Gompertz Law (e.g., Neilsen et al., 2024; and Section 5.10, below), this is not the case for excess all-cause mortality rate ($r = +0.38$, 2020-2022), and even less so for P-score mortality ($r = -0.15$, “negligible”) (**Appendix H**).

Therefore, excess all-cause mortality during the Covid period is not dominantly and directly associated to (correlated to) age structure of the population. P-score mortality, in particular, which accounts for age and frailty, is negligibly to very weakly correlated to age structure of the population. Factors other than age play dominant roles, and are linked to prevalence of poverty.

Interestingly, the correlation to “poverty” is reversed in the late Covid period (2022-H2 and 2023-H1). This relates to “persistent excess all-cause mortality into 2023” (Section 4.8) since persistent excess all-cause mortality late in and beyond the Covid period is largely associated with richer countries (Section 4.8).

5.9 Late and post-Covid-period persistent excess all-cause mortality

In Section 4.8 we described and quantified the widespread phenomenon of “persistent excess all-cause mortality in 2023”, and its systematics. In Section 5.8 we suggested that sign reversals of correlation coefficients to poverty, in the half-year periods 2022-H2 and 2023-H1, are possibly due to this same phenomenon, since wealthy (Green cluster) countries are most affected.

We submit that the said persistent excess all-cause mortality is a real phenomenon: Most countries have all-cause mortalities that return to pre-Covid levels in 2023, while the countries in issue have significant excess all-cause mortality into 2023. There are few cases of significant negative excess all-cause mortality into 2023. The analytic methods, including error propagation, appear to be robust and reliable (**Appendix A**, **Appendix B**). We have extensively tested the methodology on all the states of the USA (not shown).

The persistent excess all-cause mortality into 2023 (half-year 2023-H1), as a P-score (which accounts for age and frailty of the population), correlates to the following socio-economic variables considered (variables i—viii, Section 5.8; see **Appendix H** for all correlation coefficients, by time period):

- iv. share of population living on \leq \$30/day-person
 $r = -0.42$ (2023-H1, Figure 29)
- v. income per day
 $r = +0.35$ (2023-H1, Figure 30)
- vi. life expectancy at age 65
 $r = +0.44$ (2023-H1, Figure 31)

Importantly, these correlation coefficients for the half year 2023-H1 are of comparable magnitude but of opposite sign to the correlation coefficients for the Covid period (2020-2022).

Therefore, generally, persistent age-and-health-status-adjusted excess all-cause mortality (P-score) into 2023 occurs in low-poverty and high-life-expectancy countries, contrary to Covid-period excess mortality prior to 2023.

Essentially the same occurs with excess all-cause mortality rate (by population) (Figure 37, Figure 38, Figure 39; and **Appendix H**).

Furthermore, persistent age-and-health-status-adjusted excess all-cause mortality (P-score) into 2023 (2023-H1) correlates to COVID-19 vaccination doses administered per population, for doses administered in 2021-2022 ($r = +0.47$, Figure 42), in 2021 ($r = +0.46$, Figure 43), and in 2022 ($r = +0.37$, Figure 44), contrary (of opposite sign) to the correlation coefficients for the Covid period (2020-2022) (**Appendix I**).

Generally, countries with persistent age-and-health-status-adjusted excess all-cause mortality (P-score) into 2023 (2023-H1) have relatively highly COVID-19 vaccinated populations, are not aided by being wealthier or higher-life-expectancy countries, and would typically be countries in which COVID-19 vaccination rates among the elderly are high into 2023.

Similarly, Kuhbandner and Reitner (2024) studied the 16 federal states of Germany and found that the correlation between yearly excess all-cause mortality and vaccination rate increased significantly to a positive value in going from 2021 to 2022.

Future studies should attempt to quantitatively compare late persistent excess all-cause mortality with increases (excesses on the same time periods) in mortality associated with main specific proximal causes such as respiratory conditions, cardiac failures, and cancer.

The present study (see Section 5.12) suggests that respiratory infections or conditions would continue to be the main proximal-cause association, quantitatively. However, recent epidemiological data for Japan suggests that cancer could be a significant contributor (Gibo et al., 2024).

Immediate temporal associations between COVID-19 vaccination injection and sudden onset of aggressive cancer have been reported in a human subject (Bae et al., 2023; sarcoma at the site of injection) and in a mouse (Eens et al., 2023; catastrophic lymphoma).

Wang et al. (2020) reported molecular testing in a cohort of cancer patients to suggest definitive mechanisms of interplay between cancer growth and immune manipulations, and they showed in a mouse model that molecular immune perturbations (applications of IgG4) could significantly accelerate several types of cancers.

Kyriakopoulos et al. (2024) and Valdes Angues and Peres Bustos (2023) reviewed theoretical immunology consistent with proposed mechanisms wherein COVID-19 vaccination could cause significant acceleration of cancers.

Time will tell, if critical studies are performed and allowed to be published. The results, of course, may be different in different countries having persistent age-and-health-status-adjusted excess all-cause mortality (P-score) post-Covid period. In any case, in our view, clearly at this stage countries (which tend to be wealthy countries) should stop vaccinating for COVID-19, and should have stopped years ago.

5.10 Age dependence of sex-discriminated bulk and excess all-cause mortality in European countries

Section 4.19 provides a detailed survey of the dependence of all-cause mortality and excess all-cause mortality with age in these 25 European countries: Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, and Switzerland.

The yearly rate of all-cause mortality (by population of age group) increases exponentially with age (Figure 49). The doubling times of the yearly rate are in the range 5.7—8.9 added years in age, for the years 2019 to 2022 (Figure 49, Table 3).

The yearly rate of excess all-cause mortality (by population of age group) during the Covid period (2020-2022) also increases exponentially with age (Figure 50). The doubling times of the yearly rate for excess mortality are in the range 2.5—9.7 added years in age, excluding outliers with large errors (Figure 50, Table 4).

This means that the rate of excess all-cause mortality during the Covid period has approximately the same age dependence as the normal rate of all-cause mortality itself: both increase exponentially with age, with comparable doubling increases per added age.

Whatever the specific causes of excess deaths during the Covid period, they cause death with approximately the same age dependence as with usual deaths, approximately following the same universal law of exponential increase with age (Figure 49, Figure 50) (Gompertz Law; e.g., Neilsen et al., 2024). Whatever the agent(s) of excess deaths during the Covid period in these 25 European countries, it does not (they do not) target certain age groups or one sex very differently than with the general ambient causes of overall mortality (Figure 49, Figure 50).

However, it is possible to examine this question with higher resolution by examining the excess all-cause mortality normalized by the age-group-specific baseline (or expected mortality) rather than by the age-group specific population, which is the P-score discriminated by age group. This is done in Figure 51.

Rancourt et al. (2022b) applied this method to the states of the USA, and in the pre-vaccination and vaccination periods of the Covid period (their Figures 9, 15, 17 and 19). They showed a different age structure in the pre-vaccination and vaccination periods, with the young being disproportionately impacted in the vaccination period.

We already know from the many sections above that there is large excess all-ages all-cause mortality during the Covid period (2020-2022), with large country-to-country heterogeneity, and with large temporal variations in specific countries.

Age-dependence of excess mortality gives significant additional insight. Figure 50 (rate) and Figure 51 (P-score) show the age-dependence of excess all-cause mortality in the studied 25 European countries.

As noted above, Figure 50 shows a dominant exponential variation with age of excess all-cause mortality (by population of age group), whereas one effect of the calculation used in producing Figure 51 (P-score method) is to remove the dominant exponential variation by normalization, thereby allowing one to detect and quantify any disproportionate increase or anomalous change in mortality versus age (i.e., by age group).

With such a quantity as calculated for Figure 51 (P-score by age), zero excess all-cause mortality in a given age group would give “0 %”, and non-dependence on age would be observed for a given country if the excess and baseline mortalities had exactly the same doubling times in age (same exponential variation with age). However, the actual observed age-dependent P-score mortality above 0% shows both the magnitude and

the age-targeting from the additional fatal assaults or challenges during the Covid period, for each country and by year of the Covid period.

And we observe the following, in the 25 European countries (Figure 51).

- i. At a first level of examination, the age-group-resolved P-score mortality is generally large and positive for all age groups, throughout the Covid period (2020-2022). No age group is exempt from large excess mortality relative to the natural (pre-Covid period) baseline, and the magnitudes of this relative mortality are generally comparable across all age groups. But that is only the overall general view, prior to more detailed scrutiny of yearly and age-group differences.
- ii. Nine (9) of the 25 countries have large increases in P-score mortality with age in 2020 (Belgium, France, Italy, Netherlands, Poland, Portugal, Spain, Sweden, Switzerland). The elderly died preferentially in 2020 in these 9 countries, super-(baseline)-exponentially with age, suggesting an old-age-targeted assault during 2020. Of the 9 countries, seven (7) have exceedingly large March-April 2020 all-cause mortality peaks (20-3 feature, Section 4.2) (Belgium, France, Italy, Netherlands, Spain, Sweden, Switzerland), whereas the other (25 – 7) 18 countries essentially do not have the 20-3 feature. The said 20-3 feature (March-April 2020 mortality peak) has been associated with aggressive early medical interventions essentially following the declaration of a pandemic (Rancourt, 2020, 2023; Rancourt et al., 2020, 2021a, 2021b).
- iii. Twelve (12) of the 25 countries have comparatively small P-score mortality in 2021 in the 85+ years age group (Austria, Belgium, Bulgaria, Czechia, Greece, Hungary, Italy, Serbia, Slovakia, Spain, Sweden, Switzerland). Of these 12 countries, five (5) (Belgium, Italy, Spain, Sweden, Switzerland) have relatively large 85+ years age group mortality in 2020, which suggests a possible so-called “dry tinder effect”, although it would need to carry over for one year — between 2020 and 2021 in this age group — rather than apply in the immediate following months (e.g., Rancourt et al., 2021b, their Figure 6a). Austria uniquely (of the 25 countries) has relatively small 85+ years age group P-score mortality in each of the three years (2020-2022). Several of the countries have small or near-zero

85+ years age group P-score mortality in 2020 (Denmark, Estonia, Finland, Latvia, Lithuania, Norway).

- iv. Several countries of the 25 show an anomalously and uniquely large P-score mortality specifically in the age groups 75-79 years (France, Greece, Poland, Portugal, Spain) or 80-84 years (Austria, Czechia, Slovakia), in each of the Covid-period years (2020-2022). We note that (mid-Covid-year – mid-age-group-age) $2021 - 77 = 1944$ and $2021 - 82 = 1939$, such that the deceased would have been born essentially during the Second World War. We would hypothesize that biological stress or trauma from adversity to the pregnant mother, fetus or infant could have caused a permanent immune or other deficiency (e.g., Morey et al., 2015) making these deceased preferentially vulnerable to exceptional life-threatening assaults experienced during the Covid period.
- v. Possibly in relation to this, regarding post-war societal stress, Croatia, Romania and Serbia show an anomalously heightened P-score mortality of females compared to males in the 70-74 years age group. Here: $2021 - 72 = 1949$.
- vi. Finally, five (5) countries of the 25 show a heightened male mortality, and an exceptionally large male-female mortality gap, in the 40-44 years age group (Austria, Belgium, Denmark, Latvia, Slovakia). Two (2) other countries show a large but inverted male-female mortality gap in the 40-44 years age group, with female mortality being the largest (Greece, Serbia). It seems that this age group (40-44 years) was at high and sex-differentiated risk in several countries during the Covid period (e.g., Rancourt et al., 2021b, their Figure 8-AB, in Canada).

Several results from the age-resolved excess mortality rate (Figure 50) and age-resolved P-score mortality (Figure 51) of the 25 European countries are difficult to reconcile with the hypothesis of a specific pathogen as the dominant cause of excess mortality during the Covid period, as follows.

- A specific presumed-widespread pathogen cannot cause a large age dependence of the P-score mortality in some and not in other (here, European) countries, in the same year (Figure 51, e.g. point-ii, above).

- A specific pathogen cannot cause one age dependence of the P-score mortality one year, and a qualitatively different (even opposite) age dependence of the P-score mortality another year, in the same country, over essentially all ages (Figure 51, e.g. point-ii, above).
- The type of specific pathogen hypothesised (viral respiratory) cannot entirely or almost entirely avoid causing P-score mortality in the most elderly (85+ years age group), not to mention only in certain countries (Figure 51, e.g. point-iii, above).
- A specific and particularly virulent widespread pathogen cannot selectively target highly specific age groups (75-79 years or 80-84 years; Figure 51, e.g. point-iv, above).
- A specific pathogen cannot cause large gaps in male-female mortality in specific age groups only in certain jurisdictions, and even inverting the male-female order in other jurisdictions (Figure 51, e.g. point-v, point-vi, above).

If all the above inconsistencies in P-score mortality by age and sex are due to pre-existing underlying lethal susceptibilities in the specific countries and age groups, then one must ask “What is the meaning and utility of a hypothetical pathogen that causes death primarily in relation to pre-existing underlying conditions?”. Similarly, “How can the hypothetical pathogen be specific in its mechanism causing death if it predominantly contributes to the mortality rate (by population) exponentially with age with a Gompertz Law-like value of the doubling age (τ) (Figure 49, Figure 50), as do all the common usual causes of death that result in the Gompertz Law of mortality?”

Any largescale general regime of additional and cumulative assaults (chronic nonspecific biological stress, Selye, 1936, 1956) will cause mortality to be both primarily exponential with age (Gompertz Law) and targeted towards pre-existing underlying conditions. So, what then is the medical and epidemiological relevance of the postulated specific pathogen?

5.11 Did COVID-19 vaccine rollouts reduce all-cause mortality?

Did the unprecedented global rollouts of COVID-19 vaccines have any measurable benefit regarding all-cause mortality? Does the data show evidence that all-cause mortality was reduced by vaccine rollouts? The best way to answer this question — in the absence of vaccine-status-discriminated all-cause mortality data — is to examine the temporal evolution of all-cause mortality, before, during and after vaccine rollouts.

Watson et al. (2022) used hypothetical projections of all-cause mortality to claim that millions of lives were saved by the COVID-19 vaccines in 185 countries and territories, and their results were used to promote a Nobel Prize (see: Rancourt and Hickey, 2023). However, if the COVID-19 vaccines were effective at reducing the risk of severe illness, as is often claimed, then the impact of a known large-scale rollout during a presumed deadly pandemic should be detectable in measured all-cause mortality data directly, and its temporal dependence. Rancourt and Hickey (2023) thus argued that any purported COVID-19 vaccine efficacy is constrained by the measured mortality data itself, and demonstrated that the contrived projections of Watson et al. (2022) are necessarily false.

Appendix B shows all the available data in the present study of more than 100 countries, for all-cause mortality, excess all-cause mortality, and vaccine rollouts, by time 2018-2023, both by time interval (week or month) and as cumulative functions.

We find no example of a specific country for which all-cause mortality by time data shows a benefit attributable to vaccine rollouts. We would invite readers to identify such an example and to explain how they conclude a benefit attributable to COVID-19 vaccine rollouts.

In fact, we observe the following.

1. Large peaks of excess all-cause mortality most often continue to occur during and after COVID-19 vaccine rollouts (e.g., USA; and most cases shown in **Appendix B**).
2. The largest values of excess all-cause mortality most often occur in late 2021 (2021-H2: Table 1, Figure 16, Figure 17, **Appendix B**, **Appendix D**), after the major dose-1 and dose-2 COVID-19 vaccine rollouts of early 2021. This is shown in detail statistically (Figure 16, Figure 17).
3. In this connection, there is often a large December-2021-January-2022 peak in excess all-cause mortality (22-0 peak, Section 4.5), which is essentially synchronous with a COVID-19 vaccine (booster) rollout. Examples include: Australia, Austria, Bulgaria, Canada, Croatia, Czechia, Germany, Hungary, Latvia, Poland, Romania, and Slovakia (**Appendix B**). The case of Australia has been described in detail, and by state in Australia (Rancourt et al., 2022a). Several more cases occur in the Southern Hemisphere (Rancourt et al., 2023a), and the correlations to booster rollouts are confirmed in age-stratified data (Rancourt et al., 2023a, 2023b).
4. Many countries have no measurable excess all-cause mortality, until the vaccines are first rolled out. Examples include: Finland, Iceland, Japan, Monaco, Mongolia, Namibia, New Zealand, Norway, Singapore, South Korea, Taiwan, Thailand, and Uruguay (**Appendix B**). One can add the remarkable case of India (Rancourt, 2022).
5. To this group, we can add many cases in which virtually the only and the largest peak in excess all-cause mortality is synchronous with or immediately preceded by (usually) the first COVID-19 vaccine rollout. Examples include: Bahamas, Cuba, French Polynesia, Gibraltar, Jamaica, Malaysia, New Caledonia, Qatar, Russia, and Suriname (**Appendix B**). More examples are described in Section 4.6.
6. There is often a large December-2022-January-2023 peak in excess all-cause mortality (23-0 peak, Section 4.4), apparently coincident with an advanced booster-dose rollout, in countries with extensive COVID-19 vaccination programs, approximately four months prior to the 5 May 2023 WHO declaration

of the end of the declared pandemic. Examples include 23 of the 87 countries with sufficient data: Austria, Belgium, Canada, Chile, Czechia, Denmark, Finland, France, Germany, Ireland, Japan, Latvia, Lithuania, Macao, Netherlands, Norway, Poland, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom, and USA (**Appendix B**). We relate this to the late persistent excess mortality phenomenon, in Section 5.9.

7. There is often a significant persistent excess all-cause mortality into 2023 (2023-H1*: Section 4.8), often following and beyond the 23-0 peak described above, also extending beyond the 5 May 2023 WHO declaration of the end of the declared pandemic. This occurs in 32 of the 76 countries with sufficient data: Australia, Austria, Belgium, Brazil, Canada, Denmark, Ecuador, Egypt, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Lithuania, Netherlands, Norway, Portugal, Puerto Rico, Qatar, Russia, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, and USA (Section 4.8, Figure 14, **Appendix A**, **Appendix B**), which includes virtually all the most COVID-19 vaccinated countries in the world (Section 5.9).
8. There are no reliable correlations between excess all-cause mortalities and COVID-19 vaccine administration, which are not confounded by correlations between vaccine administration and socio-economic variables (Section 4.14, Figure 25; Section 4.17, Figure 42 to Figure 47).
9. Finally, in most countries studied, the period with significant excess all-cause mortality is lengthy (3 years or more, **Appendix A**), which is far too long in duration to be compatible with any postulated viral respiratory disease spreading by contact and producing an epidemic or pandemic, having parameters comparable to those inferred for COVID-19 (e.g., Hickey and Rancourt, 2023a, 2023b), without additionally postulating a stream of deadly “variants” for which past postulated waves of infection provide little or no cross-immunity protection, each producing its own new pandemic, a scenario never before observed or validated and previously thought to be evolutionarily unlikely. This would require a historically unprecedented stream of new deadly variants, which abruptly ends in most countries after the 5 May 2023 WHO declaration of the end of the

declared pandemic (since excess all-cause mortality then becomes relatively small or near-zero).

Therefore, despite the long (3-year) presumed period of opportunity during a declared pandemic, the extensive COVID-19 vaccination campaigns and repeated rollouts did not measurably prevent or reduce excess all-cause mortality. It would be unreasonable for anyone to conclude that COVID-19 vaccine rollouts decreased all-cause mortality, or saved any lives sufficiently to be detectable in national data and its temporal evolution.

On the contrary, as indicated in the above numbered points and as discussed below, the COVID-19 vaccine rollout campaigns are significantly associated with excess all-cause mortality.

5.12 What caused excess all-cause mortality during the Covid period?

5.12.1 Primary cause of death versus associated diseases or conditions

“Some diseases have specific causes, the direct actions of certain particular, disease-producing agents, such as microbes, poisons, or physical injuries. Many more diseases are not caused by any one thing in particular; they result from the body’s own response to some unusual situation.”

— Hans Selye (Selye, 1956; p. 179)

Given the difficulty identified by Selye, in our analysis, we distinguish between a “primary cause of death” (hierarchical top-level circumstances or stressors or assaults that cause an early or accelerated death, irrespective of the mechanism) and “associated diseases or conditions reported at death”, for example, on a clinical death

certificate (proximal or clinical causes of death in the final moments, involving organ and organ system failures or stoppages).

For example, hypothetically, infection by a specific deadly pathogen could be a primary cause of death, where the deaths, in different individuals, might be concomitantly associated with generic conditions such as “respiratory infection” and “heart failure”, and sub-categories of such conditions.

In other examples:

- A poison leads to heart failure. Then the primary cause of death is the poison.
- A poison weakens the body’s defenses, leading to a massive intestinal infection and eventual respiratory and heart co-failures. Then the primary cause of death is the poison.
- Chronic biological stress causes exhaustion-phase collapse of the body’s resistance to the biological stress, and death follows (Selye, 1956). Then the primary cause of death is the said chronic biological stress, which can be specific.
- Chronic psychological stress causes immunosuppression, enabling a severe respiratory infection from ambient microbes and air pollution, followed by death. Then the primary cause of death is the said chronic psychological stress, which can be specific.
- A person is seriously ill for some reason, even dying. A medical intervention accelerates the death, and the person dies prematurely. Then the primary cause of death is the medical intervention.

5.12.2 Inferred respiratory medical conditions in the deaths contributing to excess all-cause mortality

Prior to suggesting hypotheses about likely or possible primary causes of the deaths contributing to excess all-cause mortality, it is relevant to consider whether a dominant

syndrome, disease or condition, based on reported symptoms and conditions prior to death, can be inferred to be associated with all or most excess all-cause mortality during the Covid period.

In the high-quality databases for the USA, there is a close match between the weekly reported COVID-19 mortality and weekly excess all-cause mortality, in the entire Covid period (2020-2022), including prior to and during the vaccine rollouts (CDC, 2023).

To the degree that COVID-19 death assignment represents a serious respiratory condition at death, and given the intricate weekly temporal matching of the reported COVID-19 mortality and excess all-cause mortality for up to 3 years in the USA data, this represents strong evidence that respiratory infections were dominantly (virtually entirely) associated with excess all-cause mortality.

Rancourt et al. (2021a) showed this in detail, into 2021 (their Figures 34a through 34i). They also pointed out that more than half of the deaths assigned as COVID-19 deaths could include life-threatening co-occurring bacterial pneumonia, according to CDC tabulations of death certificates, and that prescriptions of antibiotics were significantly reduced in the same period. Rancourt et al (2021a) fervently concluded:

“Finally, our examination of plausible mechanisms for the exceptionally large COVID-era mortality in the USA, given all our empirical observations, leads us to postulate that COVID-19 may largely be misdiagnosed bacterial pneumonia (using a faulty PCR test: Borger et al., 2021; and see Ginsburg and Klugman, 2020), that correctly assigned bacterial pneumonia itself largely goes untreated, while antibiotics (and Ivermectin) are withdrawn, in circumstances where large populations of vulnerable and susceptible residents have suppressed immune systems from chronic psychological stress induced by (“COVID response”) large-scale socio-economic disruption, and that the USA has, in the COVID-era, thus recreated the conditions that produced the horrendous bacterial pneumonia epidemic of 1918 (Morens et al., 2008) (Chien et al., 2009) (Sheng et al., 2011).”

For the present purposes, these results (CDC, 2023; Rancourt et al., 2021a) imply that essentially all excess all-cause mortality during the Covid period is associated with life-threatening respiratory infections or conditions, rather than mainly associated with other conditions such as cancer, suicide, drug overdoses, homicide, delayed medical interventions, and accidents.

As emphasized above (Section 5.12.1), a dominant association to a disease or condition is separate from the question of “primary cause of death”.

Furthermore, the proposed and apparent dominant respiratory disease or condition during the Covid period relates to excess all-cause mortality, and does not preclude specific primary causes of death in individuals leading to main associated conditions at death other than respiratory infections or conditions. Such cases could produce significant mortality too small to be detected as a discernable contribution to all-cause mortality. An example might be heart failure due to COVID-19-vaccine-induced myocarditis, in which the primary cause is the vaccine. Another example could be induced immunodeficiency enabling cancer. In both examples, the increased associations at deaths could be confirmed by clinical observation or autopsy, while being too small to be recognized features in all-cause mortality data.

The proposal that respiratory infections or conditions are the dominant association with (not primary cause of) excess all-cause mortality during the Covid period is further supported by additional lines of evidence.

- (*Already outlined above:* Intricate weekly temporal matching of the reported COVID-19 mortality and excess all-cause mortality for up to 3 years during the Covid period in the USA data.)
- Respiratory infections are a major recognized cause of death for all ages, both historically and presently, which is consistent with the intrinsic vulnerability of the lungs and the unavoidable rate of constant breathing.

- The median ratio of all-cause mortality to reported COVID-19 mortality for the countries in the present study is 1.55 (Figure 22), which is not too different from 1.
- Many deaths occurred from early aggressive hospital treatments for respiratory conditions, such as mechanical ventilators, toxic experimental doses of drugs, and lethal palliative drug cocktails (March-April peak, “20-3” feature) (e.g., Bailey and Köhnlein, 2020; Chaillot, 2024 (their Chapter 6); Menage, 2021; Rancourt, 2020, 2023; Richardson et al., 2020; Roedl et al., 2021; Torjesen, 2021; Watts et al., 2021).
- The VAERS system of adverse effect reporting contains many post-vaccination nominally COVID-19 infections (e.g., Hickey and Rancourt, 2022, their Figures S3(a) and S4(a)).
- Post-vaccination nominally COVID-19 infections are common, and are generally more frequent and more serious following multiple COVID-19 vaccine doses (1st dose, 2nd dose, booster) (Amer et al., 2024, their Table 6).

Furthermore, from a mechanistic point of view, all forms of bacterial pneumonia have unreasonably been overlooked and left untreated during the Covid period (Rancourt et al., 2021a).

In particular, as one example, tuberculosis (TB) is a category of ancient bacterial pneumonias, which is highly prevalent and deadly, which is a leading proximal cause of death in the world, and which is clearly linked to social and economic factors, especially of household or residential living conditions.

In Section 5.4 we linked a mortality discontinuity between Eastern and Western European countries during the Covid period to the post-1990s pre-Covid-period prevalence of active TB, as an indicator of or proxy for large socio-economic differences.

Apparent transmission of TB, from infectious persons to household members, is well established (e.g., Chapman and Dyerly, 1964), such that transmission in hospital, care-home and prison settings is expected and high prevalence and incidence are demonstrated (Baussano et al., 2010; Joshi et al., 2006).

One-third of the world population is estimated to be infected with the TB pathogen, 9–14 million confirmed active cases occur every year, and there are approximately 1.2 million confirmed TB deaths per year in regular recent times (Bagcchi, 2023; Dattani et al., 2023; O'Garra et al., 2013).

It is estimated that there may be up to 10 times more active pathological TB cases than the above reviewed numbers, not confirmed by bacteriological tests (e.g., Houben et al., 2022), which would represent approximately 100 million active cases in any year.

Therefore, it appears that humanity's evolutionary and pervasive coexistence with TB represents a large (and sufficient) reservoir of potential respiratory ailments ready to enter the world stage whenever mass events suppress immunity (next section), not counting the multitude of other prevalent bacterial, fungal and co-infection pneumonias (Dietert et al., 2017; Liu et al., 2023; Torres et al., 2021).

In conclusion, it is plausible that virtually all excess all-cause mortality during the Covid period is associated with respiratory infections or conditions. This is likely to be the case in the USA, which is a large country with diverse populations of vulnerable individuals, living in diverse socio-economic, institutional, climatic and environmental conditions. In addition to confirming evidence, there is no counter evidence that this would not also be the case in other countries in the present study.

Therefore, our hypotheses about primary causes of death in excess all-cause mortality during the Covid period (next section) should be consistent with this finding of respiratory condition prevalence.

Regarding the particular microscopic pathogen to blame for the proximal respiratory conditions: You can only see what you look for (if the test is reliable), and you can't see what you don't look for.

A similar situation appears to apply to the 1918 pandemic, in which virtually all excess mortality was associated with respiratory conditions or infections (autopsy confirmed as bacterial pneumonia), whereas the primary cause of death in excess all-cause mortality would have been the conditions imposed by the First World War (Bailey et al., 2024), in the post-war socio-economic adjustment circumstances.

5.12.3 Primary causes of death in excess all-cause mortality during the Covid period

5.12.3.1 Stress of mandates and measures

It would be difficult to overestimate the importance of biological stress (which includes psychological stress) in causing death, irrespective of the mechanism.

Selye (1956) defined biological stress and made an encyclopedic and systematic review of the many diverse stressors studied in the scientific literature up to 1976 (Selye, 1976a). Fatal physiological consequences of chronic biological stress have been known and extensively studied since their initial discovery (Selye, 1936, 1956, 1976a; Szabo et al., 2017).

While being foundational, the Selye line of research did not (Selye, 1976b) and has not generally (Szabo et al., 2017) included two paramount factors:

- i. The role of social dominance hierarchy, in both human and animal societies, as a structural and leading source of complex, situational and time-dependent stressors (dominance aggression) that primarily determine an individual's (social-status-dependent) health and longevity.

- ii. The dependence of biological adaptation and failure (collapse) on, not solely whether the biological stress is acute (episodic) or chronic (constant), and not solely on how the stress is experienced by the particular individual, but critically on the time sequence of the acting stressors of varying intensities; that is, on their time-type-intensity spectrum, which can have both regular and chaotic components.

More generally, as is now known, the health and survival of individuals among social animals, and primates in particular, is predominantly determined by the individual's position and role in the dominance hierarchy, in relation to the physiology and biochemistry of dominance aggression (Sapolsky, 2005), including via respiratory infections (Cohen et al., 1997a). Irrationality or randomness of the acts of dominance aggression plays an important role, via stress response mechanisms, and amplifies the harm to subordinate individuals (Silk, 2002).

Together, these studies (e.g., Selye, Sapolsky, Cohen, Silk) are clear that socially and environmentally mediated biological stress is a major determinant of death and survival. This is easily admitted for non-human animals. However, the current medical scientific literature generally shies away from admitting the prevalence of such brutality in human societies, and instead tends to focus on sanitized questions of immunology and individual psychological stress.

From the perspective of the immune system, ordinary psychological stress alone significantly impacts immune response, and psychoneuroimmunology is a large field of research (Ader and Cohen, 1993; Dhabhar, 2009, 2014). Purely psychological stress alone probably causes many varied and common diseases (Cohen et al., 2007). Psychological stress and social isolation have strong associations with respiratory infections, including the common cold, acting to increase both frequency and severity of the infection (Cohen et al., 1991, 1997a, 1997b). Meanwhile, the impact of age increases vulnerability to stress (Prenderville et al., 2015). "Immunosuppressive activity increases with aging", as the immune system is "remodeled" (Salminen, 2022). Some

aspects of psychological stress in the Covid period context have been reviewed by Peters et al. (2021).

Regarding stressors acting in the USA during the Covid period, and their social-status dependence, Rancourt et al. (2021a) summarized this way:

“Therefore, it is not difficult to imagine that the massive socio-economic disruptions of the COVID-era would have caused undue chronic psychological stress and amplified dominance-hierarchy stress predominantly against those who are already at the bottom of the societal dominance hierarchy, and have the least means to adjust to dramatically new circumstances. The new circumstances include: loss of sources of income, both legitimate and illegal, increased social isolation, increased hierarchical impositions, constant fear propaganda, severe mobility restrictions, closing of public and corporate-public spaces previously used, enforcement and intimidation against private or informal gatherings, mobbing against those who do not cheerfully accept the “new reality”, and increased aggressions from equally stressed individuals. The missing means to adjust would include: undisturbed salary and ability to work from home, means to stay connected by Zoom (by video conferencing applications), large comfortable air-conditioned homes, means to home-school children in an adapted environment, nearby facilities for outside exercise, private facilities for physical exercise, undisturbed shopping by home delivery, undisturbed self-medication, continued access to health care, and so on.”

Finally, a recent study of young mice is strikingly apropos. Li et al. (2023) found that mice subjected to a single episode of restraint and immobilization stress (single 5–20 h stress sessions of confinement) experienced severe immunosuppression, more so and differently than with other common laboratory stressors (cold, biochemical). The behaviourally stressed mice could not efficiently defend against intravenous challenge with bacteria, and also showed significant spleen macrophage cell death, among several other corroborating biochemical observations.

This study in mice (Li et al., 2023) suggests, on a mechanistic basis, that confinement and isolation in humans may have a significant negative effect on susceptibility to

infections, consistent with field observations of college students (Cohen et al., 1991, 1997b), and non-human primates (Cohen et al., 1997a).

For a human society under lockdown, the same universal enforced confinement to one's home, for example, will in-effect consist of very different confinement intensities depending on social class and financial means, for obvious reasons.

We conclude this sub-section with the hypothesis that the Covid-period mandates and measures were a primary cause (Section 5.12.1) of death significantly contributing to the measured excess all-cause mortality.

See: (Rancourt et al., 2021a, 2021b) (Rancourt et al., 2022b, their boxed figure in their Conclusion).

5.12.3.2 Medical interventions other than COVID-19 vaccination

There is much evidence that medical interventions (including denial of treatment) other than COVID-19 vaccination caused premature deaths during the Covid period, which would not have occurred otherwise until later (e.g., Rancourt, 2020, 2023; Rancourt et al., 2021a, 2022b, 2023a, and references therein).

In this regard, we must have the evidence-based perspective that, even in ordinary times, medicine itself is a leading cause of harm and death (Gøtzsche, 2016; Makary and Daniel, 2016; Panagioti et al., 2019; and references therein).

The said medical treatments would include:

- coordinated denial of antibiotics or Ivermectin against bacterial pneumonia
- systematic use of mechanical ventilators and their associated medications
- experimental treatment protocols (large-dose hydroxychloroquine, HCQ)
- new palliative and psychological medication protocols, overdoses (e.g., midazolam) (Marliot et al., 2020; Sy, 2024)
- isolation of vulnerable individuals in medical or institutional facilities

- denial of intensive care and disease management facilities
- denial of home and community care medical services
- aggressive-testing accidents
- accidents and infections from reduced attending staff in care homes
- encouraged voluntary or involuntary assisted dying (Marliot et al., 2020; Menage, 2021; Sy, 2024)
- increased prevalence of medical errors due to declared-pandemic conditions

The March-April 2020 peak often occurring in all-cause mortality (20-3 feature, Section 4.2), in particular, is difficult to explain absent medical interventions (Rancourt, 2020, 2023). See also: Bailey and Köhnlein, 2020; Chaillot, 2024 (their Chapter 6); Richardson et al., 2020; Roedl et al., 2021; Torjesen, 2021; Watts et al., 2021.

We conclude this sub-section with the hypothesis that medical interventions (other than COVID-19 vaccination, including denial of treatment) were a primary cause (Section 5.12.1) of death significantly contributing to the measured excess all-cause mortality.

This medical intervention primary cause of death hypothesis is not invalidated by the background of biological stress that would have characterized the Covid period, since the relevant medical interventions accelerated the deaths that would not have otherwise occurred until later.

5.12.3.3 COVID-19 vaccination

Rancourt (2022) and Rancourt et al. (2022a, 2023a, 2023b) have shown many examples of strong temporal associations between rapid COVID-19 vaccine rollouts and peaks in excess all-cause mortality, in more than 20 countries and states, including in age stratified data.

Evidence from the present study showing that COVID-19 vaccination is associated with increased excess all-cause mortality, rather than reduced mortality, is highlighted above in Section 5.11.

In addition, we observe the following specific associations between COVID-19 vaccine rollouts and peaks or increases in excess all-cause mortality (**Appendix B**):

- i. 30% of countries (37 of 124) have no detected excess all-cause mortality in all of 2020, only later when vaccines are rolled out*
 - 124 countries have sufficient all-cause mortality data (the data for Cabo Verde is too noisy) to determine whether excess all-cause mortality started after the end of 2020, after the vaccines were introduced.
 - Of these 124 countries, 37 countries (30% of countries) have no detectable excess all-cause mortality in 2020. For at least the first nine months of the declared pandemic (declared on 11 March 2020) these 37 countries had virtually no measurable excess all-cause mortality: Antigua and Barbuda, Australia, Barbados, Bermuda, Brunei, Cuba, Faroe Islands, Finland, French Guiana, French Polynesia, Gibraltar, Greenland, Hong Kong, Iceland, Jamaica, Japan, Macao, Malaysia, Martinique, Mauritius, Monaco, Mongolia, Namibia, New Caledonia, New Zealand, Norway, Philippines, Réunion, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Seychelles, Singapore, South Korea, Suriname, Taiwan, Thailand, and Uruguay.
 - To this list of 37 countries, we can add India (Rancourt, 2022).
 - All these 37 + 1 countries have first peaks or increases in excess all-cause mortality (if present) occurring only after vaccination is initiated, or later when the bulk of injections have been administered and additional (booster) doses are rolled out.
- ii. 100% of countries (110 countries with sufficient vaccination data) show varied associations between vaccine rollouts and excess mortality*

- 110 countries of the 125 countries in the present study have sufficient data (both vaccination and mortality data, which is not too noisy) to allow determinations of temporal associations.
- There are significant correlations between COVID-19 vaccine rollouts and peaks or increases in excess all-cause mortality in all 110 of these countries (100% of countries) having sufficient data: Albania, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, Bahamas, Barbados, Belgium, Belize, Bermuda, Bolivia, Bosnia, Brazil, Brunei, Bulgaria, Canada, Chile, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czechia, Denmark, Dominican Republic, Ecuador, Egypt, Estonia, Faroe Islands, Finland, France, French Guiana, French Polynesia, Georgia, Germany, Gibraltar, Greece, Guadeloupe, Guatemala, Hong Kong, Hungary, Iceland, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kuwait, Latvia, Lebanon, Liechtenstein, Lithuania, Luxembourg, Macao, Malaysia, Maldives, Malta, Mauritius, Mexico, Moldova, Monaco, Mongolia, Montenegro, Namibia, Netherlands, New Caledonia, New Zealand, Nicaragua, North Macedonia, Norway, Oman, Palestine, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Romania, Russia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Serbia, Seychelles, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Suriname, Sweden, Switzerland, Taiwan, Tajikistan, Thailand, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, USA, Uruguay, and Uzbekistan.

iii. 97% of countries (113 of 116) show a late-2021 early-2022 peak in excess all-cause mortality temporally associated with booster rollouts

- There are 116 of the 125 countries in the present study that have sufficient and sufficient-quality data to ascertain the presence of the “22-0 feature”, a prominent or statistically evident excess mortality peak occurs within one month or so of 1 January 2022 (Section 4.5). Of these 116 countries, 113 countries have the 22-0

feature in their excess all-cause mortality data (Section 4.5). The other 3 countries do not measurably exhibit the 22-0 feature (Italy, Macao, Taiwan).

- Therefore, 113 of 116 countries (97% of countries) exhibit a peak in excess all-cause mortality within one month or so of 1 January 2022 (the 22-0 feature, Section 4.5) coincident with (immediately following) the time at which many booster doses were synchronously rolled out globally. The booster rollouts are recognized as peaks in overall (all doses) COVID-19 vaccine administration (e.g., Rancourt et al., 2023a).
- The 113 countries having discernable 22-0 features in excess all-cause mortality are: Albania, Andorra, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Barbados, Belgium, Belize, Bermuda, Bolivia, Bosnia, Brazil, Brunei, Bulgaria, Cabo Verde, Canada, Chile, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czechia, Denmark, Dominican Republic, Ecuador, Egypt, Estonia, Faroe Islands, Finland, France, French Guiana, French Polynesia, Georgia, Germany, Greece, Guadeloupe, Guatemala, Hong Kong, Hungary, Iceland, Iran, Ireland, Israel, Jamaica, Japan, Jordan, Kazakhstan, Kosovo, Kuwait, Kyrgyzstan, Latvia, Lebanon, Liechtenstein, Lithuania, Luxembourg, Malaysia, Maldives, Malta, Martinique, Mauritius, Mayotte, Mexico, Moldova, Monaco, Mongolia, Montenegro, Namibia, Netherlands, New Caledonia, New Zealand, Nicaragua, North Macedonia, Norway, Oman, Palestine, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Réunion, Romania, Russia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, San Marino, Serbia, Seychelles, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Suriname, Sweden, Switzerland, Tajikistan, Thailand, Transnistria, Tunisia, Turkey, Ukraine, United Kingdom, USA, and Uruguay.
- Among these 113 countries having discernable 22-0 features in excess all-cause mortality, some of the most striking correlations between a peak in vaccine rollout and the 20-2 feature occur for the 12 countries: Australia (and see: Rancourt et al., 2022a, 2023a, 2023b), Austria, Czechia, Hong Kong, Hungary, Poland, Qatar, Romania, Russia, Saint Vincent and the Grenadines, Slovakia, and Ukraine.

iv. *64% of countries (50 of 78) show a late-2022 early-2023 sharp peak in excess all-cause mortality temporally associated with booster rollouts*

- There are 78 of the 125 countries in the present study that have sufficient and sufficient-quality data to ascertain the presence of the “23-0 feature”, a prominent or statistically evident excess mortality peak that occurs within one month or so of 1 January 2023, less than 5 months prior to the declaration of 5 May 2023 of the end of the declared pandemic (Section 4.4).
- Of these 78 countries with sufficient data, 50 countries have the 23-0 feature (Section 4.4) in their excess all-cause mortality data. These 50 countries are: Austria, Belgium, Canada, Chile, Croatia, Cyprus, Czechia, Denmark, Ecuador, Estonia, Finland, France, French Guiana, Germany, Greece, Guatemala, Hong Kong, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Macao, Moldova, Netherlands, New Zealand, Norway, Paraguay, Poland, Portugal, Puerto Rico, Qatar, Russia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Tunisia, Turkey, United Kingdom, and USA.
- The other 28 of the 78 countries with sufficient data do not measurably exhibit the 23-0 feature (Section 4.4). These 28 countries are: Albania, Armenia, Azerbaijan, Bosnia, Colombia, Egypt, Faroe Islands, Georgia, Guadeloupe, Kazakhstan, Kosovo, Kyrgyzstan, Malaysia, Martinique, Mayotte, Mexico, Mongolia, Montenegro, North Macedonia, Oman, Philippines, Réunion, Serbia, Uruguay, Bulgaria, Mauritius, New Caledonia, and Romania.
- Therefore, 50 of 78 countries (64% of countries) exhibit a peak in excess all-cause mortality within one month or so of 1 January 2023 (the 23-0 feature, Section 4.4) coincident with (immediately following) the time at which many booster doses were synchronously rolled out globally, in the last booster rollout prior to the declaration of the end of the declared pandemic. The booster rollouts are recognized as peaks in overall (all doses) COVID-19 vaccine administration (e.g., Rancourt et al., 2023a).

- Although Bulgaria does not have the 23-0 feature (a distinct peak near 1 January 2023), it does have a broader and somewhat earlier peak structure in its excess all-cause mortality, which matches the vaccine rollout at that time (mid to end of 2022). Similar circumstances may be occurring in: Albania, Armenia, Colombia, Egypt, Georgia, Malaysia, North Macedonia, Philippines, Mauritius, and New Caledonia.

v. *Particularly striking examples of vaccine-mortality associations in several specific countries*

- Several countries show striking examples of vaccine-mortality associations in which the vaccine rollout is synchronous with the only exceptionally large excess all-cause mortality feature: Bahamas, Cuba, French Polynesia, Gibraltar, Jamaica, Japan, Malaysia, New Caledonia, and Suriname. Here, note that Cuba developed its own vaccine.
- Similarly striking examples include: Guadeloupe, Hong Kong, Maldives, Mauritius, Namibia, Philippines, Qatar, and Tunisia.

Therefore, there are many temporal associations between COVID-19 vaccine rollouts and increases in excess all-cause mortality, in every country with sufficient data.

It is highly unlikely that these many vaccine-mortality temporal associations — occurring at many different times for different vaccine rollouts during the two years of vaccinations and in every country having sufficient mortality and vaccination data in the present study — are coincidental.

These vaccine-mortality correlations occur even with the limitation that the contributions to all-ages excess all-cause mortality by population are exponential with age (Section 5.10) whereas the vaccine administration shown (**Appendix B**) is for all ages, and there are many more injections to non-elderly than to elderly, administered in different rollouts. Observed vaccine-mortality correlations are generally most distinct

with age stratified data and can be masked in all-ages data (Rancourt et al., 2023a, 2023b).

Possible mechanisms whereby COVID-19 vaccination could be a primary (Section 5.12.1) cause of death include:

- a. The injection causes death by direct toxicity. Cationic lipids are candidates for toxic components.
- b. The injection causes death by inducing an immune overreaction. The resulting immune assault, analogous to an allergic reaction, is enough to accelerate and cause the death.
- c. The injection and repeated injections (2nd dose and boosters) cause immunosuppression making the patient generally more susceptible to infections and less able to defend against existing infections, including respiratory infections, in turn causing death. (See Section 5.12.2 regarding Amer et al., 2024, their Table 6.)
- d. A frail patient is infected or additionally infected by a person who was made more infectious by injection-induced immunosuppression — either another patient or a caregiver, for example. Their death is accelerated where it otherwise would not have been.

Regarding point-c, for example, following Selye (1956), if subjected to widespread (even booster-repeated) presence of antigens in the blood, the body could respond by suppressing its non-specific inflammation response, including in the respiratory tract, thus making the individual more susceptible to varied and deeper respiratory infections (and skin infections: Martora et al., 2023). Also, theoretical mechanisms specifically for COVID-19 vaccine-induced immunosuppression have been suggested (Palmer et al., 2023, ss. 3.3—3.5; Seneff et al., 2022).

These possible mechanisms (point-a through point-d) are consistent with the observations based on age-stratified data that the effective “vaccine dose fatality rate

(vDFR)” (per injection basis) increases exponentially with age and increases with the dose number (Rancourt et al., 2023a, 2023b).

We conclude this sub-section with the hypothesis that COVID-19 vaccination was a primary (Section 5.12.1) cause of death significantly contributing to the measured excess all-cause mortality.

This COVID-19 vaccine injection primary cause of death hypothesis is not invalidated by the background of biological stress that would have characterized the Covid period, or by the assaults from other medical interventions, since the injections are taken to have accelerated the deaths that would not have otherwise occurred until later.

5.12.3.4 SARS-CoV-2 as a primary cause of death

The hypothesis of a specific viral respiratory pathogen causing excess all-cause mortality during the Covid period (2020-2022) is contrary to two main direct observations:

- i. It is incompatible with the large country-to-country heterogeneity of age and frailty adjusted (P-score) excess all-cause mortality rate (Section 5.5, Section 5.7).
- ii. It is incompatible with the country-to-country spatiotemporal pattern of deaths, including the phenomenon of not crossing national borders. There is no evidence of spread, only local (by country) and time-specific assaults that do not geo-temporally evolve (Sections 4.11, 4.12, 5.6).

These basic incompatibilities have been previously reported (Rancourt, 2020, 2022; Rancourt et al., 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b). For example, in India there was no detectable excess all-cause mortality until the vaccine was first rolled out starting in March 2021 (Rancourt, 2022).

It is highly unlikely also that the frequently observed (in all countries, and repeatedly) peaks in excess all-cause mortality following the start or completion of COVID-19 vaccination rollouts, including boosters, occur from new variants of pandemic potency, for which no cross-immunity has been achieved (after more than one or two years of declared pandemic and typically more than one year of universal vaccination). For example, specific hypotheses of new variants of concern — corresponding to extraordinary coincidences following rapid vaccine rollouts — are argued to having been fabricated in the cases of India (Rancourt, 2022) and Australia (Rancourt et al., 2022a).

In addition to being incompatible with definitive and repeated observations, the SARS-CoV-2 hypothesis (or the hypothesis of any specific pandemic-causing respiratory virus) as a primary (Section 5.12.1) cause of death during the Covid period is not needed to explain any feature of the all-cause mortality in any of the countries studied.

The more immediate hypotheses of biological stress, medical interventions, and vaccination largely suffice. There was biological (including psychological) stress, induced by aggressive and life-changing mandates. There were deadly medical interventions (including denial of treatment), motivated by institutional messaging and overreaction. There was a global vaccination campaign with multiple rollouts, driven and protected by aggressive establishment and industry forces. All-cause mortality is a record of the consequences.

5.13 Calculated risk of death per injection from COVID-19 vaccines

5.13.1 Population-wide risk of death per injection — all ages

In this section we make quantitative estimates of the population-wide risk of death per COVID-19 vaccine injection, based on excess all-cause mortality and vaccine rollout data for the 100 or so countries in the present study.

We calculate the said risk as the number of excess deaths divided by the number of administered injections in a chosen time period. The chosen time periods typically capture both the excess mortality features of interest and the injections presumed to be associated with the excess mortality.

This ratio can be referred to as the vaccine dose fatality rate (vDFR). It is a population-wide risk of death per injection expressed as a percentage of the number of injections. It can be dose specific and it can be resolved by age group (Rancourt et al., 2022a, 2023a, 2023b).

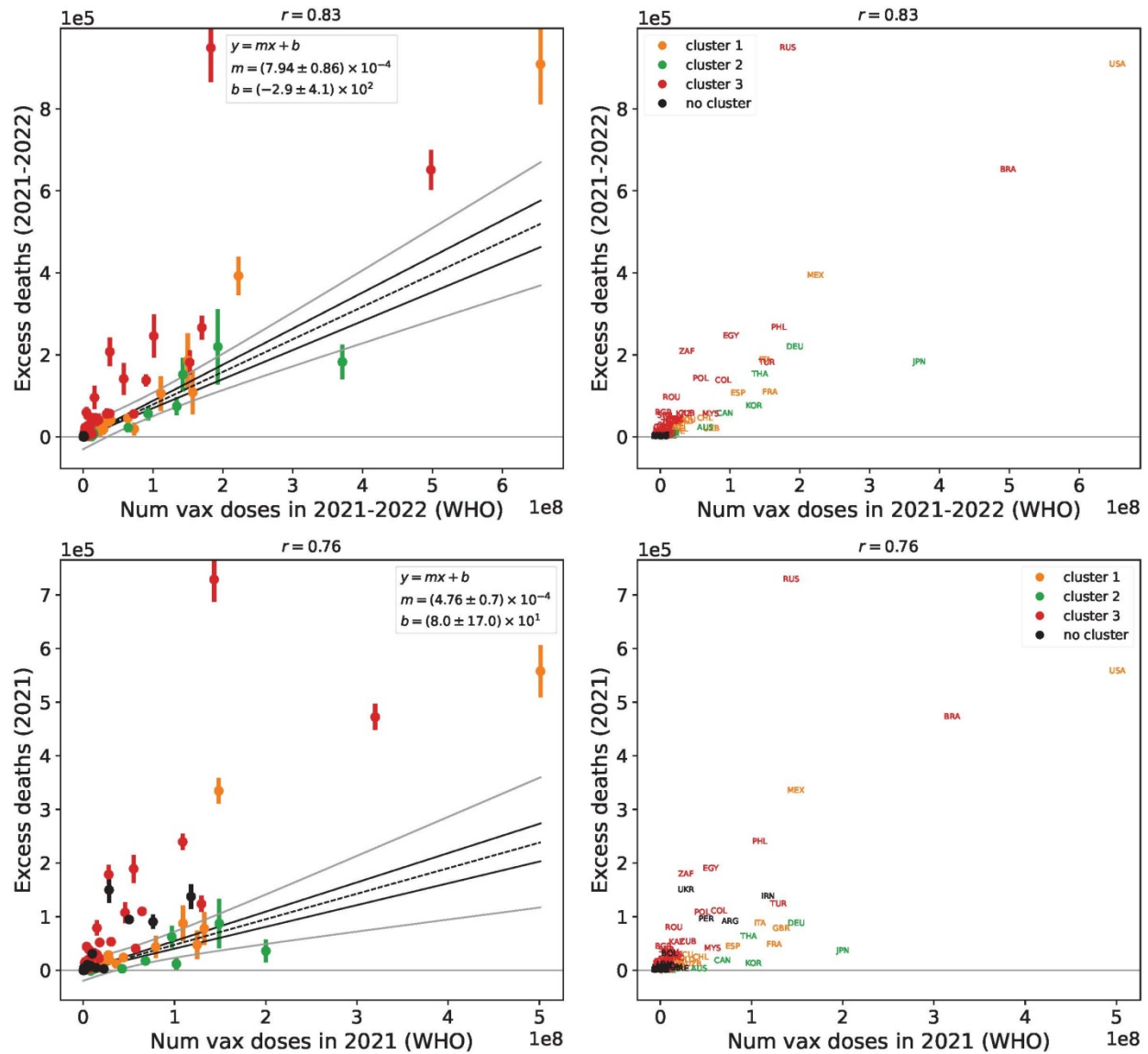
Depending on the time period, the injections may include mostly first and second doses, or booster rollouts (3rd dose, 4th dose). The different vaccine manufacturers are not resolved in the present calculations.

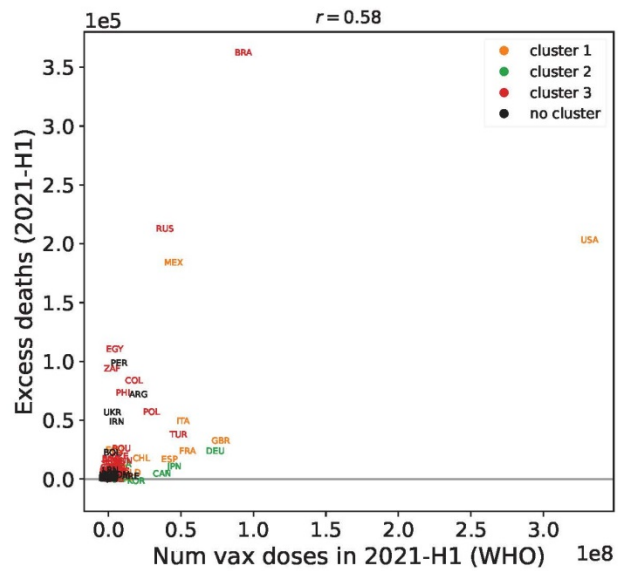
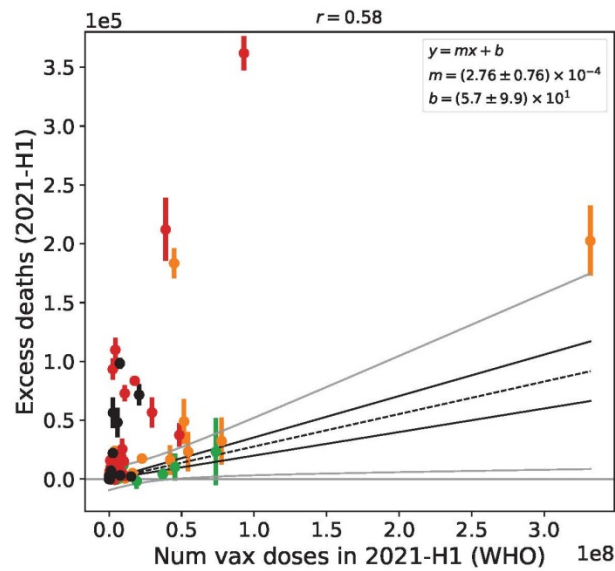
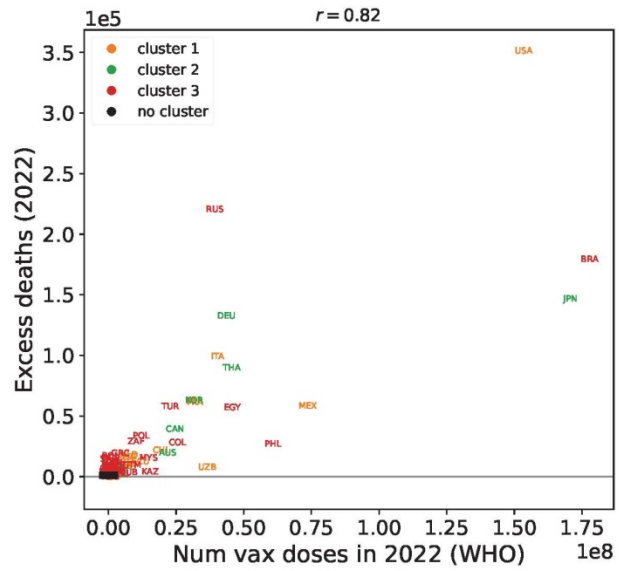
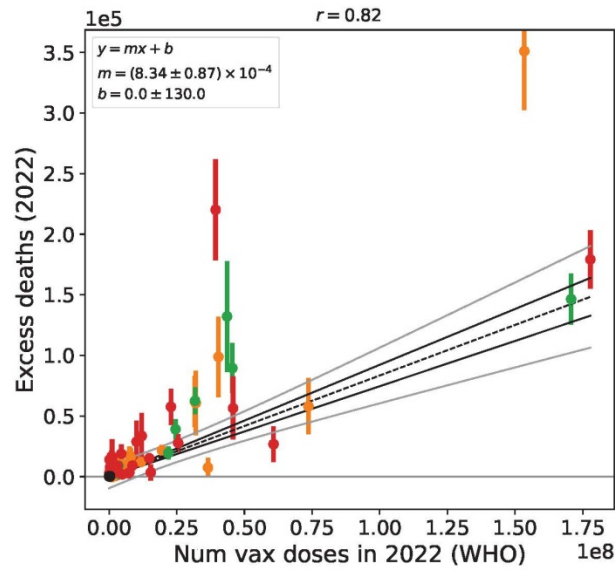
For example, if we select the time period to be essentially the entire vaccination period (that is, if we select the 2-year period 2021-2022), then we are evaluating the combined effects of all injections within this time period without discerning different doses, and we are including all excess all-cause mortality peaks that may individually be due to distinct doses.

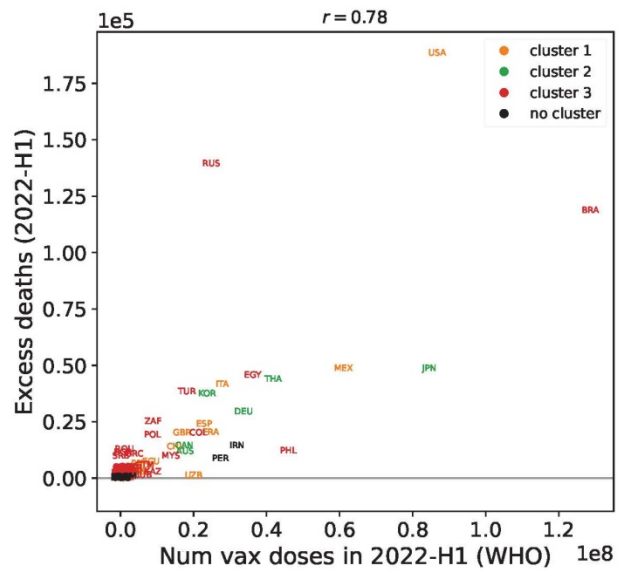
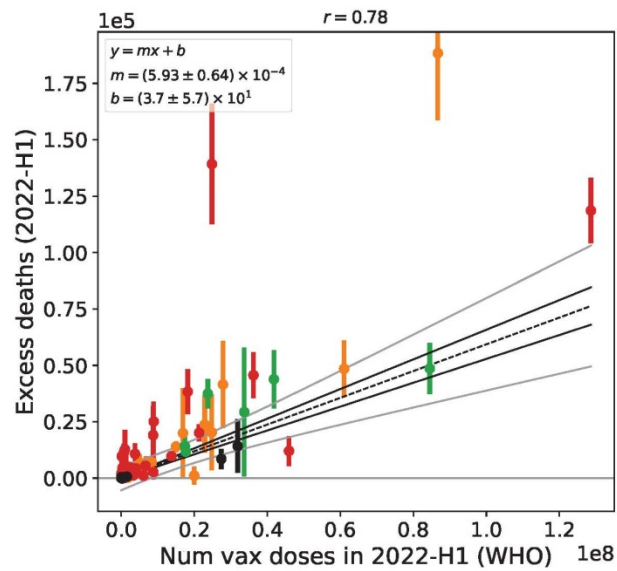
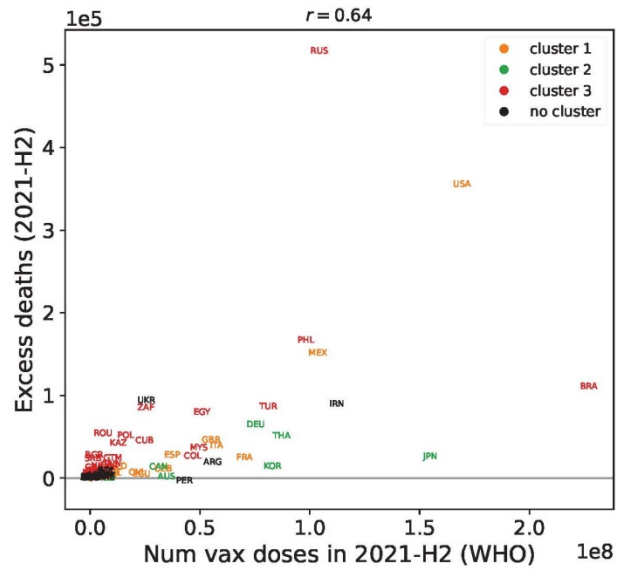
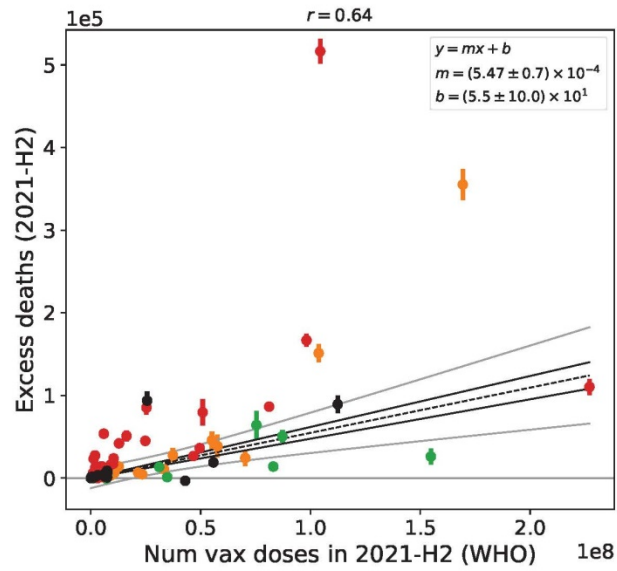
Furthermore, the calculation presumes that the only primary (Section 5.12.1) cause of (excess mortality) death in the time period is vaccination (Section 5.12.3.3). If other primary causes of death contribute to excess mortality in the time period then the calculated ratio will be an overestimate of the vDFR. This would produce positive outliers in a scatter plot (for all countries) of excess mortality versus number of administered injections.

Examples of such scatter plots are shown in Figure 52, for all the countries with sufficient data, and for the time periods 2021-2022, 2021, 2022, 2021-H1, 2021-H2, 2022-H1, and 2022-H2 (half years).

Figure 53 shows the same as Figure 52 (scatter plots of excess all-cause mortality versus number of COVID-19 vaccine injections, by country, by cluster, for different time periods) but with a 4-fold zoom on both x and y axes, near the origin.







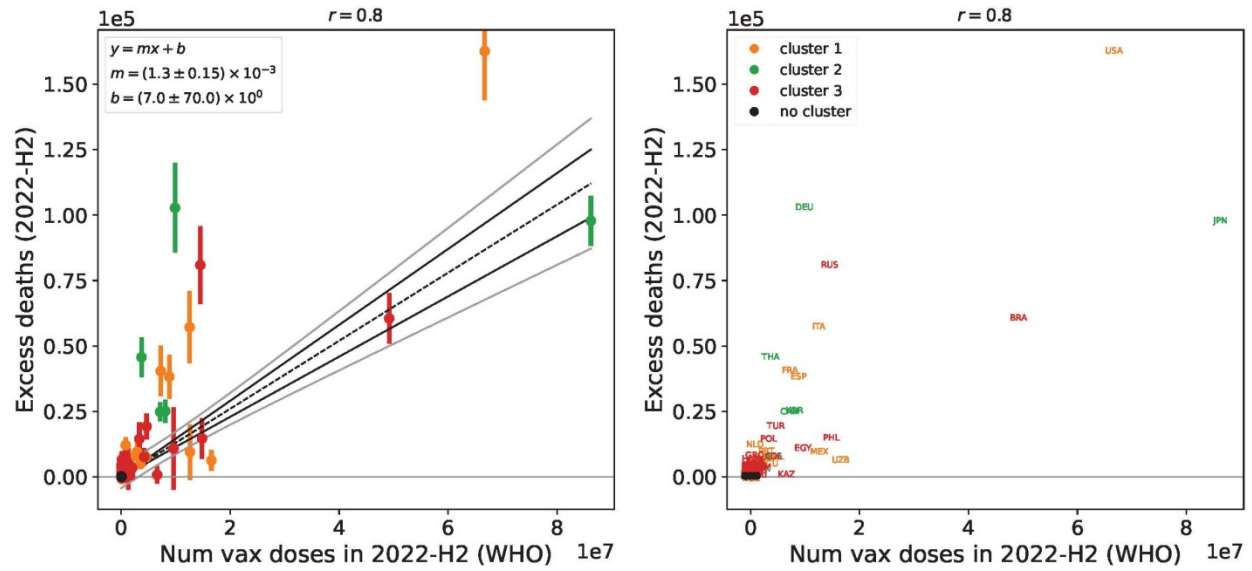
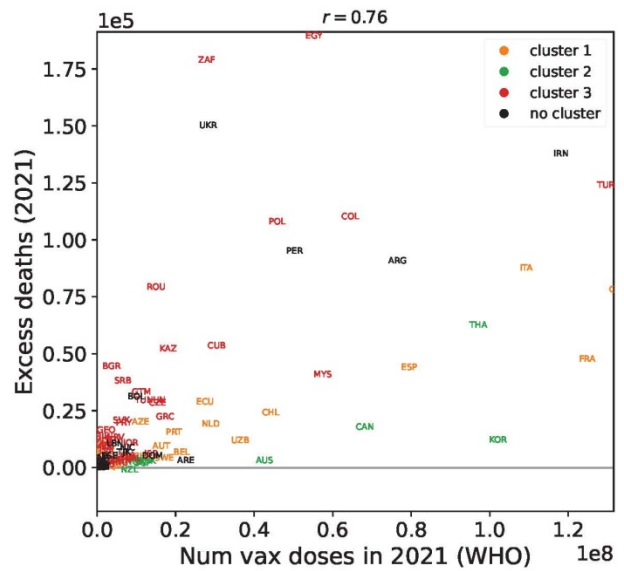
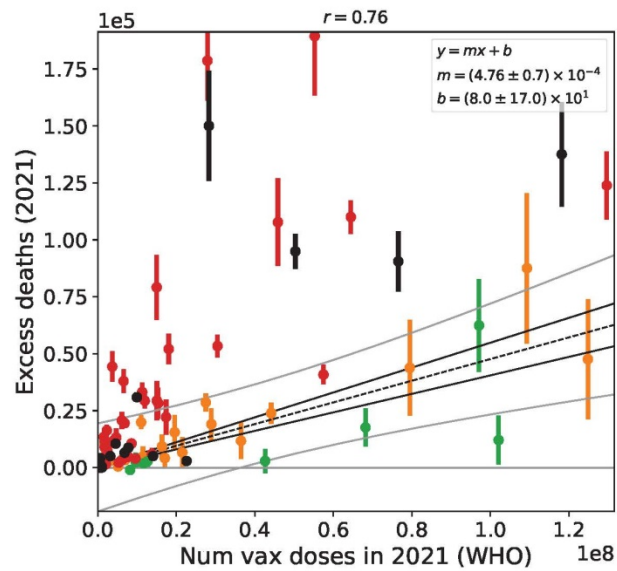
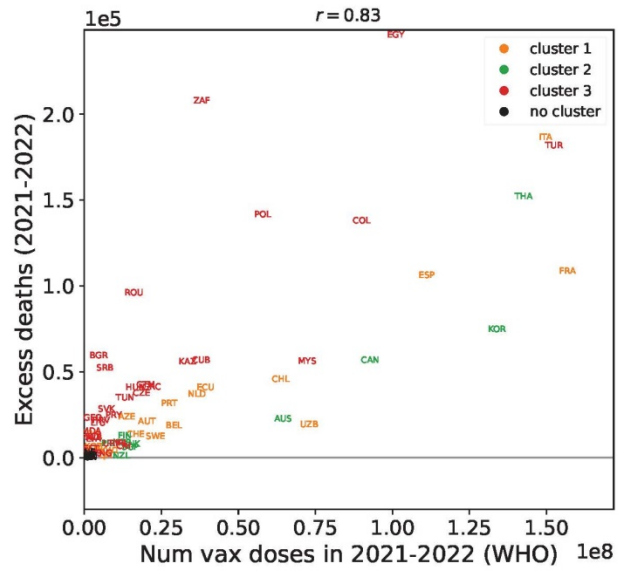
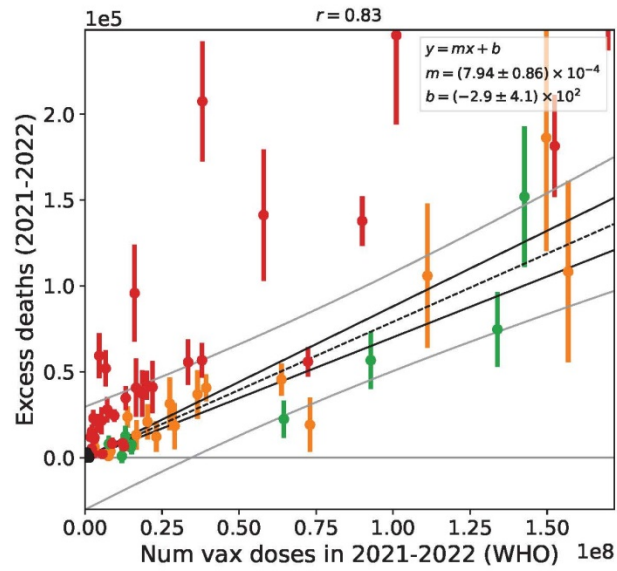
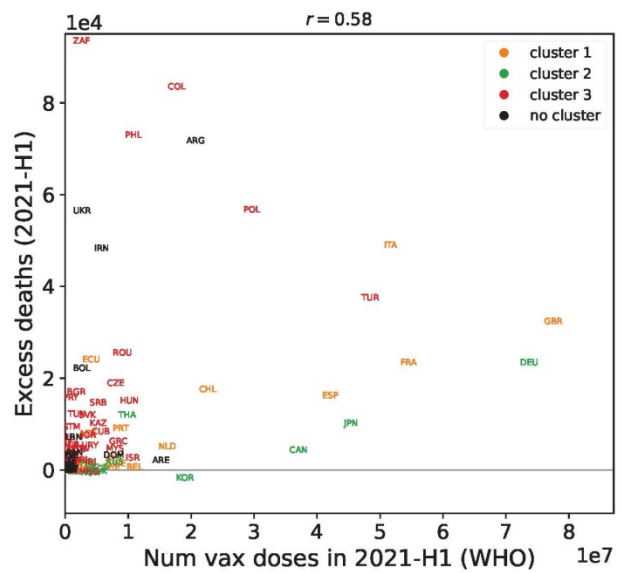
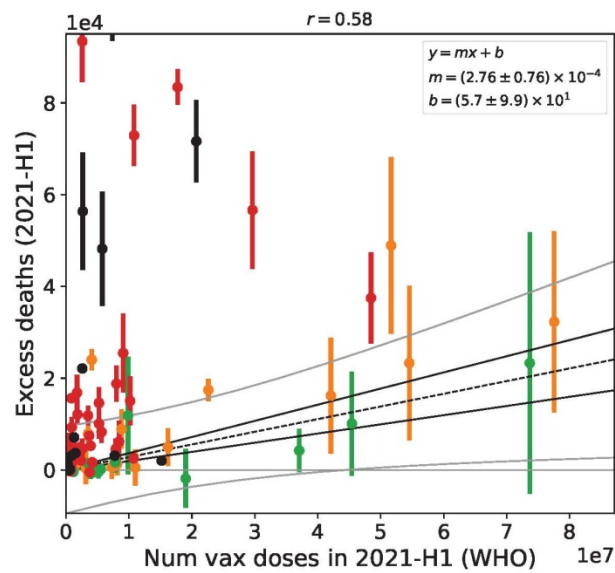
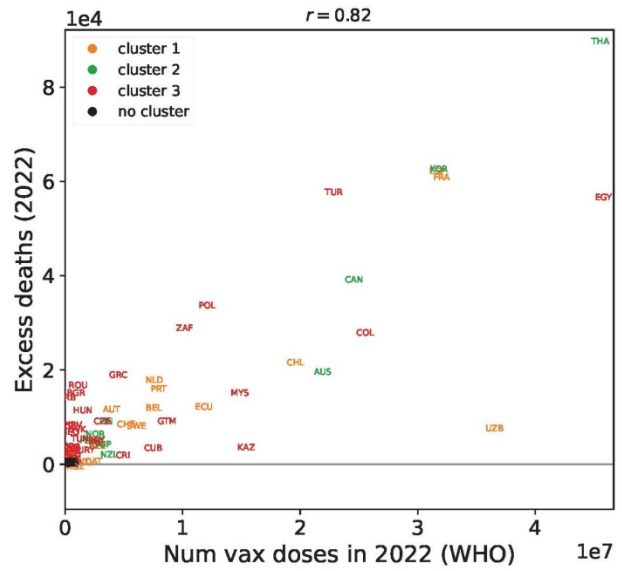
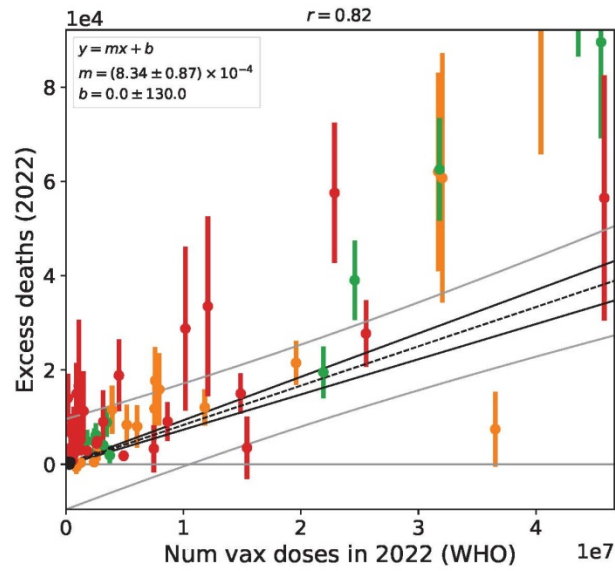
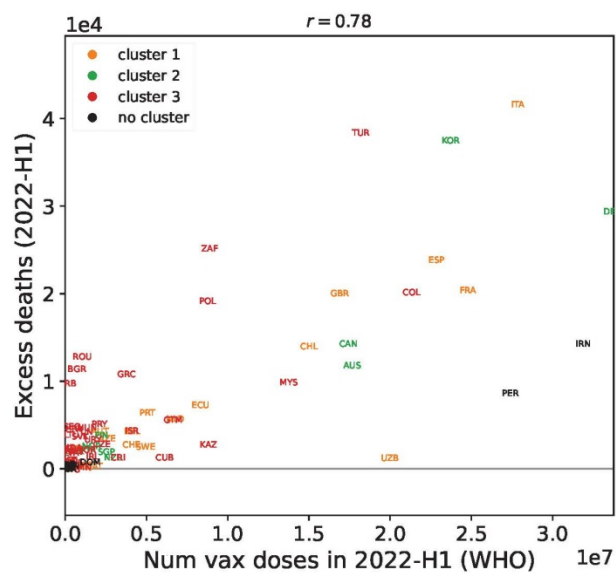
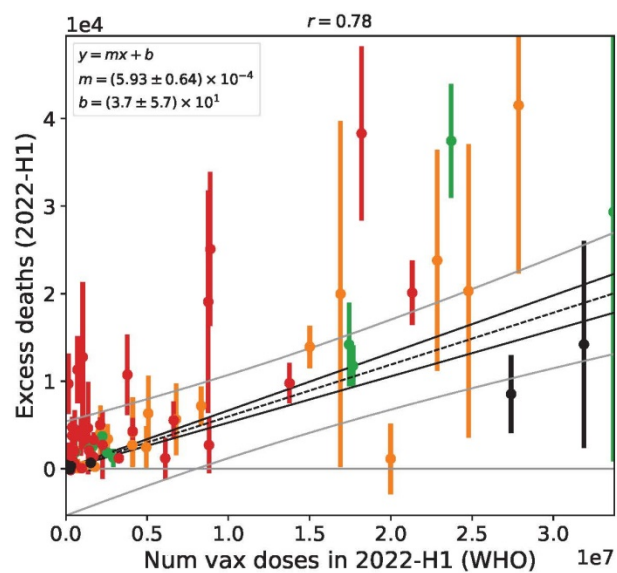
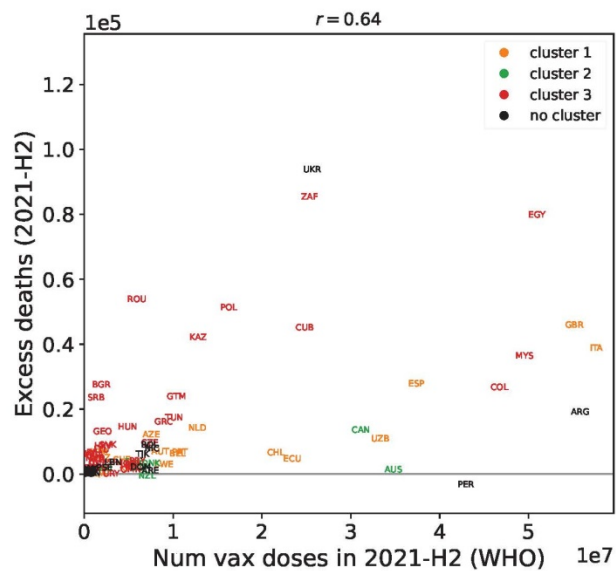
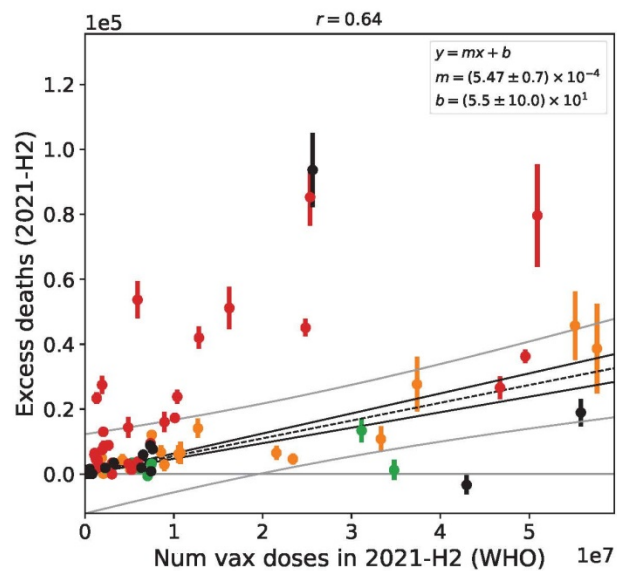


Figure 52. Scatter plots of excess all-cause mortality versus number of COVID-19 vaccine injections, by country, by cluster, for different time periods. The straight-line fit parameters (slope and intercept), the cluster colours (cluster analysis), the pearson correlation coefficient, and the country codes (right panel) are shown for each time period.







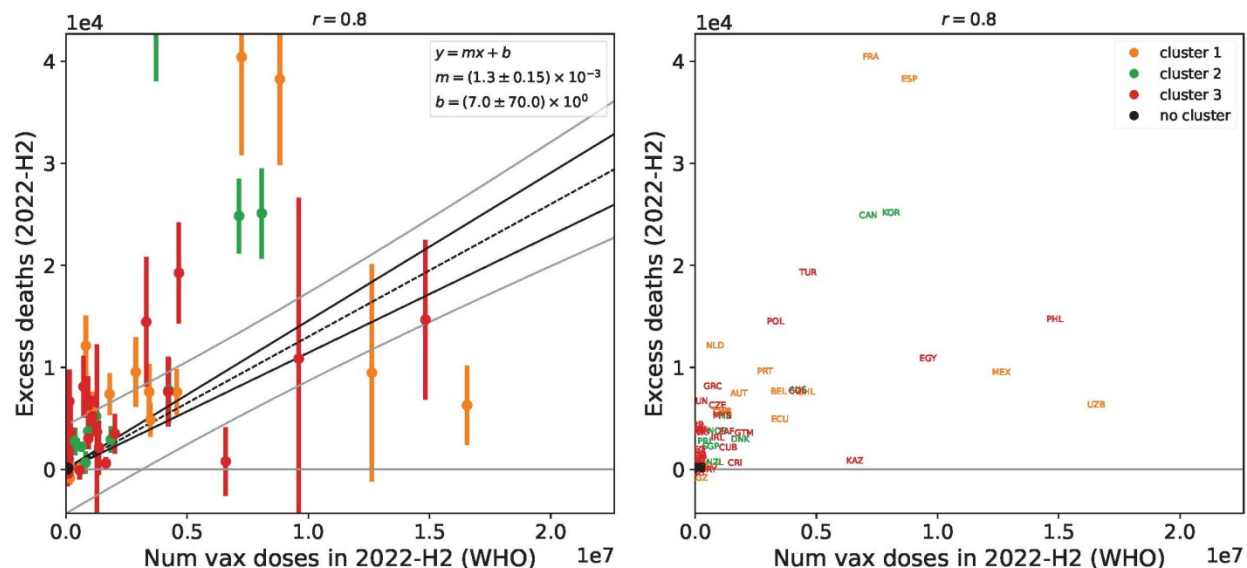


Figure 53. Same as the previous figure (scatter plots of excess all-cause mortality versus number of COVID-19 vaccine injections, by country, by cluster, for different time periods) but with a 4-fold zoom on both x and y axes, near the origin.

In Figure 52 and in Figure 53, the following analytic curves are shown. These are the same for a given time period in both figures.

- (1) The best straight-line fit (least squares fit) using the Y-errors in the points, assumed to be proportional to the true error (dashed black line)
- (2) Upper and lower bounds on the best straight-line fit, using largest intercept and largest slope or smallest intercept and smallest slope, respectively, within the error bounds on intercept and slope (solid black lines)
- (3) The standard confidence-interval limits, not using Y-errors, and therefore assuming equal and normal Y-errors for all points (curved grey lines)

For all the time periods in Figure 52 (and Figure 53), the correlations are generally strong ($r \geq 0.60$) or very strong ($r \geq 0.80$), and the intercepts are zero within error, which implies proportionality. The excess all-cause mortality in these time periods is proportional to the number of COVID-19 vaccine injections given.

The slope of the best-line fit in Figure 52 (and Figure 53) corresponds approximately to the mean all-ages all-manufacturers all-doses all-countries (in this study) population-

wide risk of death per COVID-19 vaccine injection, for the given time period, expressed as a fraction (rather than as a percentage) in the legends for the panels.

The positive outliers (above the fitted line) in Figure 52 (and Figure 53) correspond to countries and time periods when there are additional primary causes of death (Section 5.12), other than the vaccine. Typically, countries that had large excess mortalities in 2020, prior to vaccine rollouts, may be positive outliers in Figure 52. See also Rancourt et al. (2023a).

We can also calculate the ratio of excess mortality to number of COVID-19 vaccine injections for a given country and for a given time period. This ratio is an estimate of the population-wide risk of death per injection (vDFR), to the degree that the injections performed during the time period are the primary (Section 5.12.1) cause of death for the excess mortality in the same time period in the given country.

This ratio, expressed as a percentage of the number of injections, is shown for all 78 countries (as labelled) with sufficient data for the 2-year time period 2021-2022 in Figure 54. Here, the groups of countries identified in the cluster analysis (Section 4.7) are shown using the cluster colours on the symbols. The statistical parameters of the corresponding distribution of values are given in the legend of the figure.

The median value for 2021-2022 is 0.127% (Figure 54). The outliers (with values significantly above the median value) tend to be countries in the red cluster (e.g., Eastern European countries), which have exceptionally large excess mortality in late 2020 immediately prior to the first vaccine rollouts in early 2021.

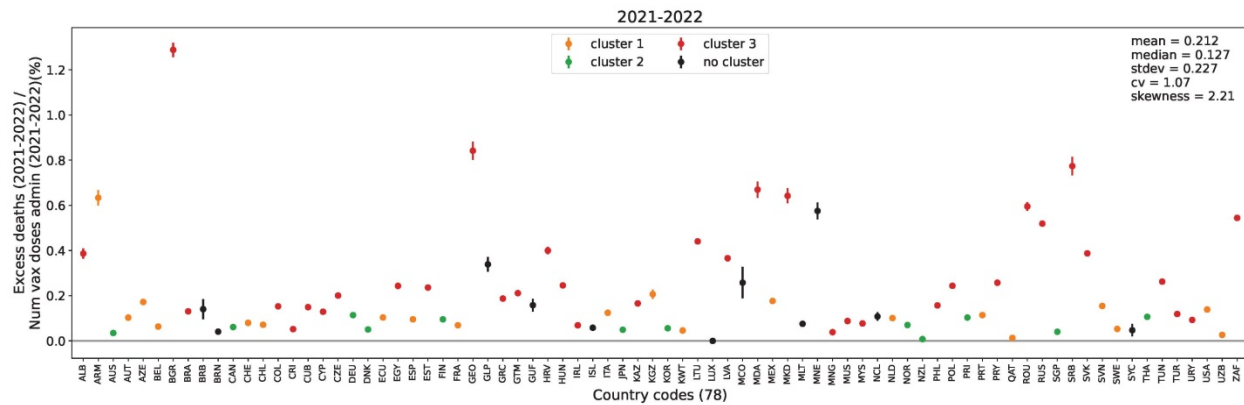


Figure 54. Values of excess mortality divided by number of COVID-19 vaccine injections, by country (as labelled), by cluster (as per colour), for the period 2021-2022. The statistical parameters of the distribution of values are given in the legend.

Using the median value for 2021-2022 of 0.127% for the 78 countries with sufficient data (Figure 54) gives an estimate of global all-ages excess mortality associated with the COVID-19 vaccines up to 30 December 2022 as:

$$0.00127 \times 13.3 \text{ billion doses administered up to 30 December 2022 (OWID, 2024)} \\ = \\ 16.9 \text{ million COVID-19-vaccine-associated deaths}$$

This is solely an estimated representative number since, as shown below, the population-wide risk of death per injection (vDFR) varies significantly by dose number (1st dose, 2nd dose, boosters) (or time period) and exponentially with age, and since the median method itself is an estimation. Table 5 and Table 6 give overviews of evaluations of time-period-dependent all-ages vDFR values.

Table 5 is a collection of estimated values of the population-wide risk of death per injection (vDFR), expressed as a percentage of the number of COVID-19 vaccine injections, in different time periods (2021-2022, 2021, 2022, and the half years in 2021 and 2022), by two different methods:

- (1) from the slopes in best-line fits in Figure 52, and
- (2) as the median values from figures such as Figure 54.

Table 5. Estimated population-wide risk of death per COVID-19 vaccine injection (vDFR), as a percentage of the number of injections, by time period, for two methods (scatter plot, median)

Time period	N, countries	From slope in scatter plot (%)	From median in scatter (%)
2021-2022	78	0.0794 \pm 0.0086	0.127
2021	108	0.0476 \pm 0.0070	0.108
2022	78	0.0834 \pm 0.0087	0.197
2021-H1*	110	0.0276 \pm 0.0076	0.091
2021-H2	108	0.0547 \pm 0.0070	0.106
2022-H1	86	0.0593 \pm 0.0064	0.125
2022-H2	78	0.130 \pm 0.015	0.408

*2021-H1 is the first half year of 2021, and so forth.

By comparison, previously published estimates of all-ages population-wide risk of death per COVID-19 vaccine injection (vDFR) are given in Table 6.

Table 6. Published values of population-wide risk of death per COVID-19 vaccine injection (vDFR)

Country	vDFR (%)	Reference	Time period of excess mortality
India	1.1	Rancourt, 2022	April-July 2021
high-poverty states, USA	1.	Rancourt, 2022	fall 2021
Australia	0.05	Rancourt et al., 2022a	January-February 2022
Australia	0.0515 \pm 0.0014	Rancourt et al., 2023b (their Table 1)	vaccination period

Israel	0.0527 ± 0.0030	Rancourt et al., 2023b (their Table 2)	vaccination period
17 countries, Southern Hemisphere	0.02 (New Zealand) — 0.20 (Uruguay)	Rancourt et al., 2023a	January-February 2022
17 countries, Southern Hemisphere	0.126 ± 0.004	Rancourt et al., 2023a	vaccination period

Therefore, the estimate of all-ages population-wide risk of death per injection (vDFR) made by Rancourt et al. (2023a) for 17 countries in the Southern Hemisphere during the vaccination period (0.126 ± 0.004) % is confirmed by the present study based on 78 countries with sufficient data (Table 5).

Importantly, the all-ages all-countries vaccination-period values are representative (“average”) values. Table 5 and Table 6 show that there are large variations with health status (by country), and with dose number (higher doses at later time periods). Additionally, there is an exponential variation with age (next section).

Much of the country-wise (by cluster) and dose-wise (by half year) variability is captured in Figure 55. Here, the median-value determination of the population-wide risk of death per COVID-19 vaccine injection (vDFR) is shown versus half-year time period in 2021 and 2022, for the different clusters of countries (as colour coded, cluster analysis, Section 4.7) and for all countries (blue).

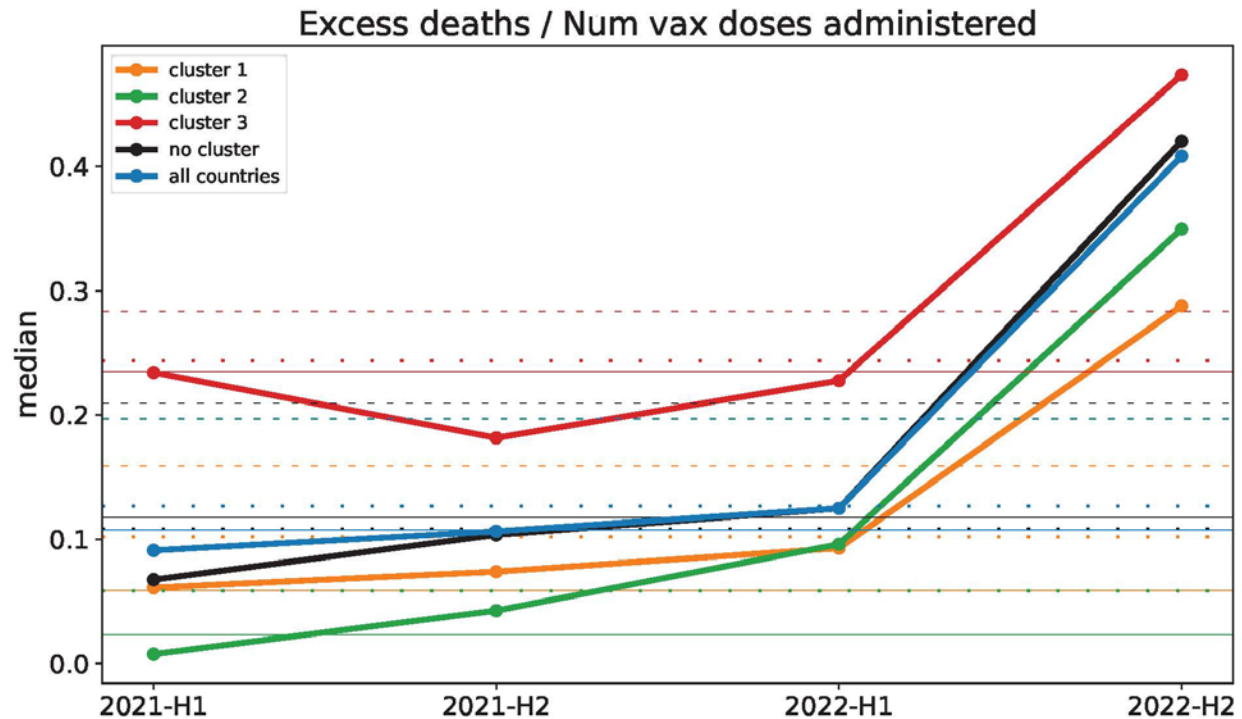


Figure 55. Population-wide risk of death per COVID-19 vaccine injection (vDFR), as a percentage of the number of injections, versus half year, obtained from the median value, by cluster of countries (cluster analysis) and for all countries (as per legend).

There is generally an increase with higher doses (at later times) (Figure 55), which has been reported previously from age-stratified and dose-discriminated data (Rancourt et al., 2023a, 2023b).

There is also generally an upward shift of the values towards clusters of countries with lower health status (green < orange < all-countries:blue = undetermined:black < red) (Figure 55).

These observations (Table 5, Table 6, Figure 55) are consistent with the above described hypothesis in which the vaccine acts to suppress immune response (and more so with more doses to a given individual), thus making already frail and sick vaccine-injected individuals more likely to succumb via fatal respiratory conditions (Section 5.12, Section 5.12.3.3).

5.13.2 Population-wide risk of death per injection — stratified by age group

We have shown above that excess all-cause mortality increases exponentially with age, in 25 European countries with sufficient data (Section 5.10, Section 4.19, Figure 50).

The population-wide risk of death per COVID-19 vaccine injection (vDFR) also increases exponentially with age (Rancourt et al., 2023a, 2023b).

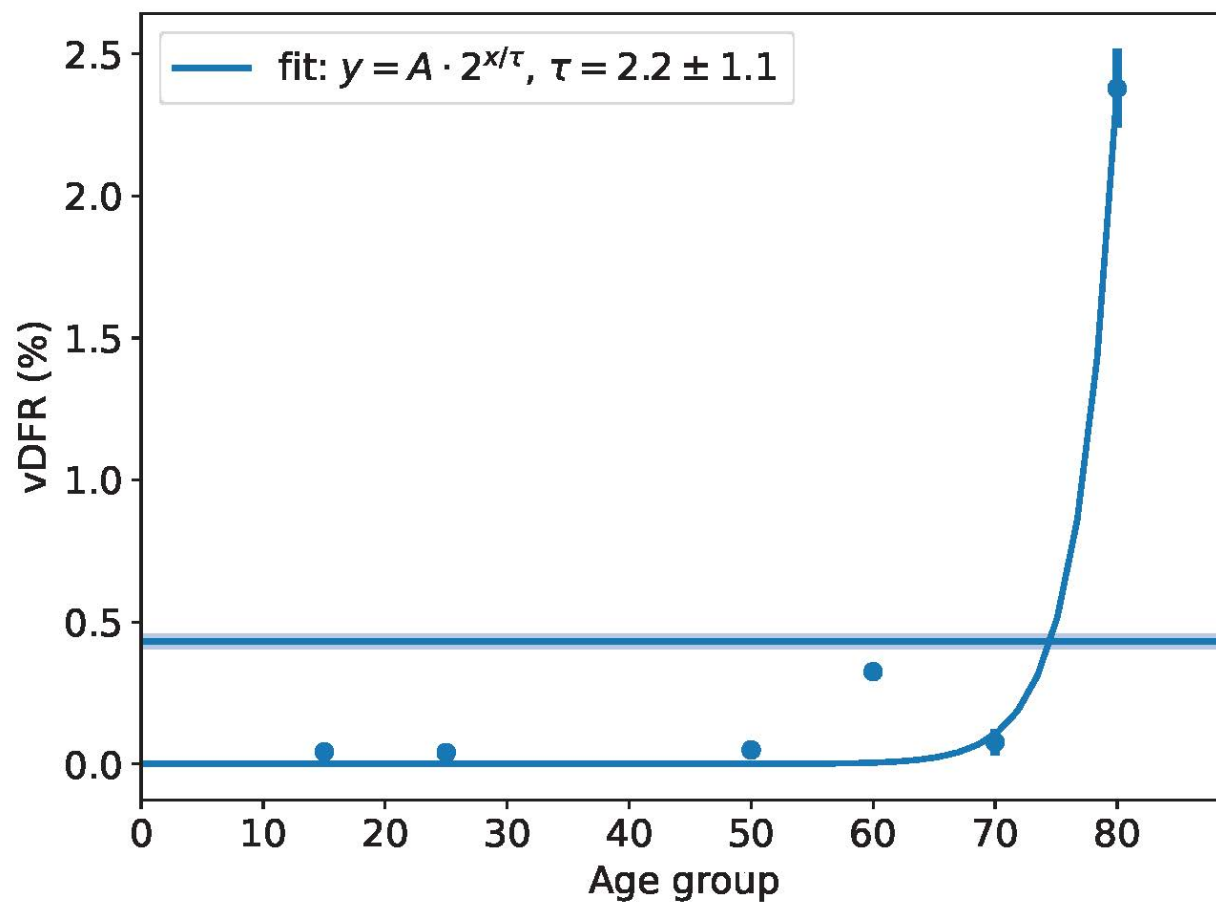
This is shown in the present study for the time period 2022-H2 (second half year of 2022, when boosters are administered) for 25 countries with sufficient data in Figure 56.

Here (Figure 56), the 25 countries are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Finland, France, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. The all-ages value of vDFR is shown in the panel of each figure as a horizontal line with 1σ error shading. The parameters of each exponential fit are given in the legend for the panel for the specific country.

Austria (AT)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

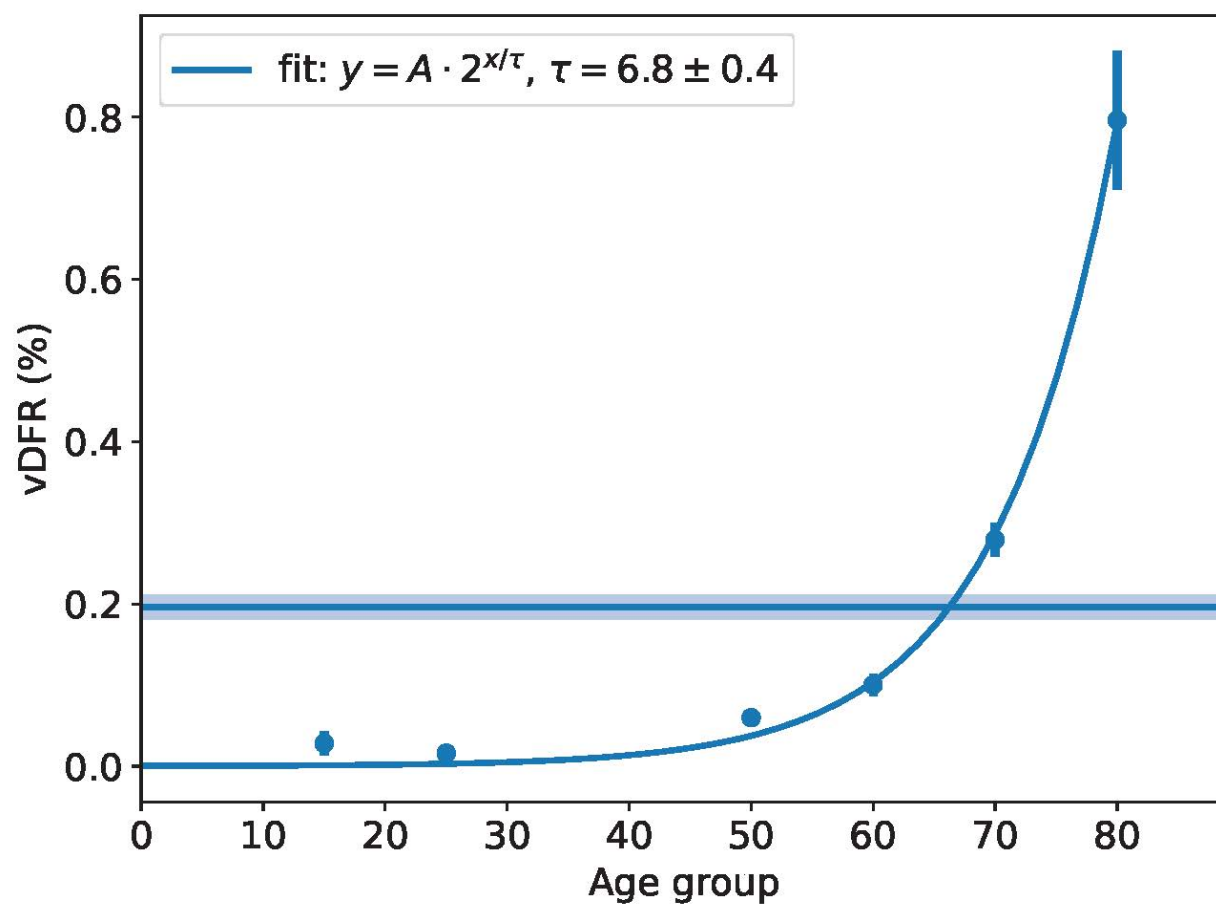
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Belgium (BE)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

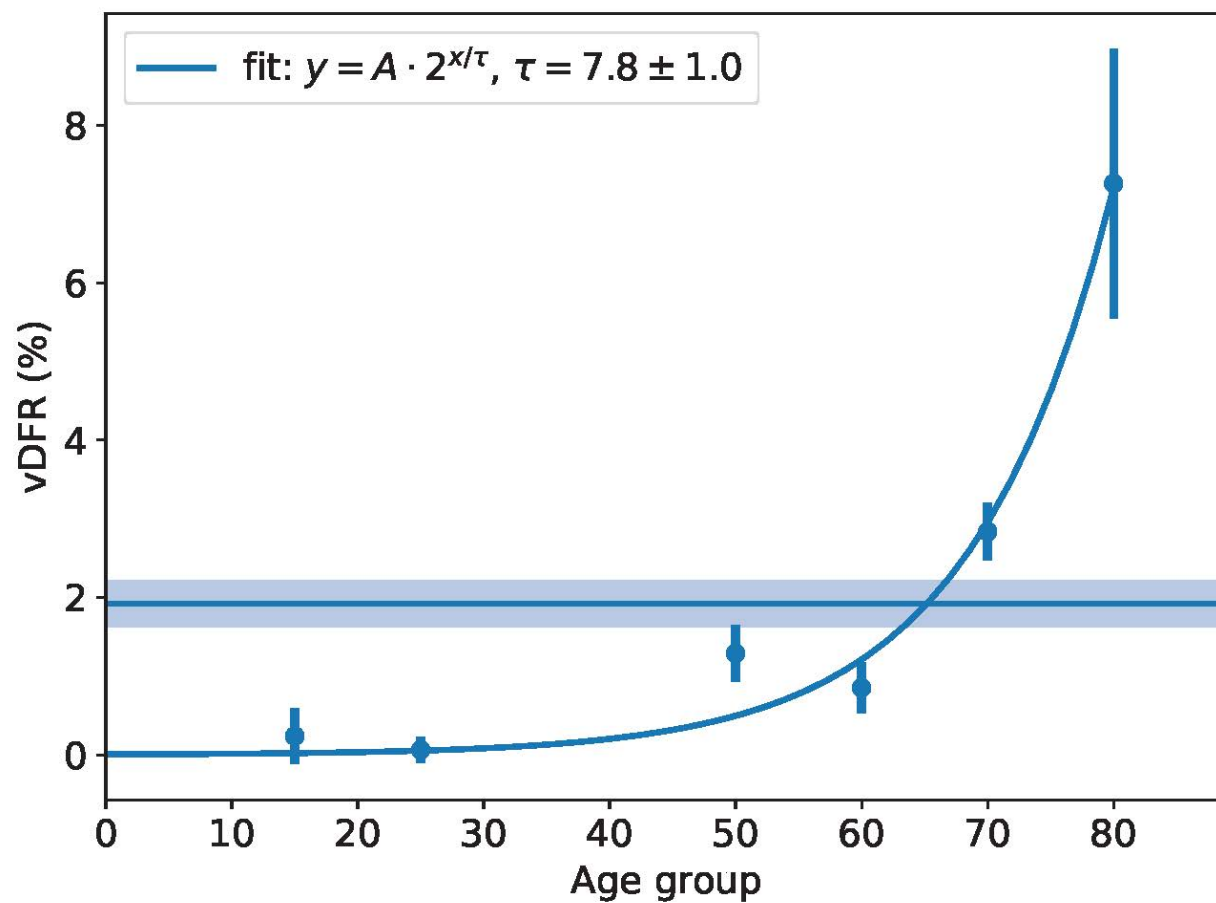
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Bulgaria (BG)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

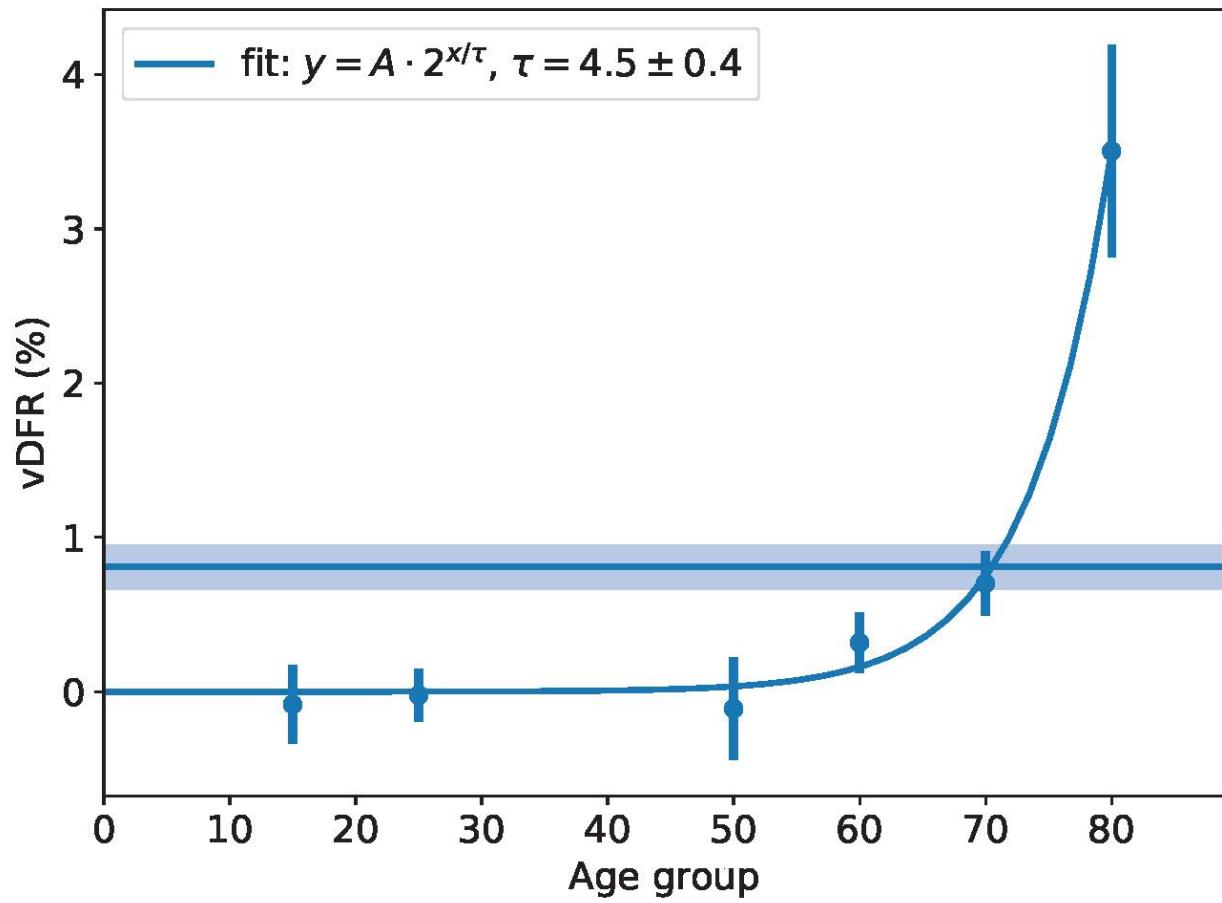
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Cyprus (CY)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

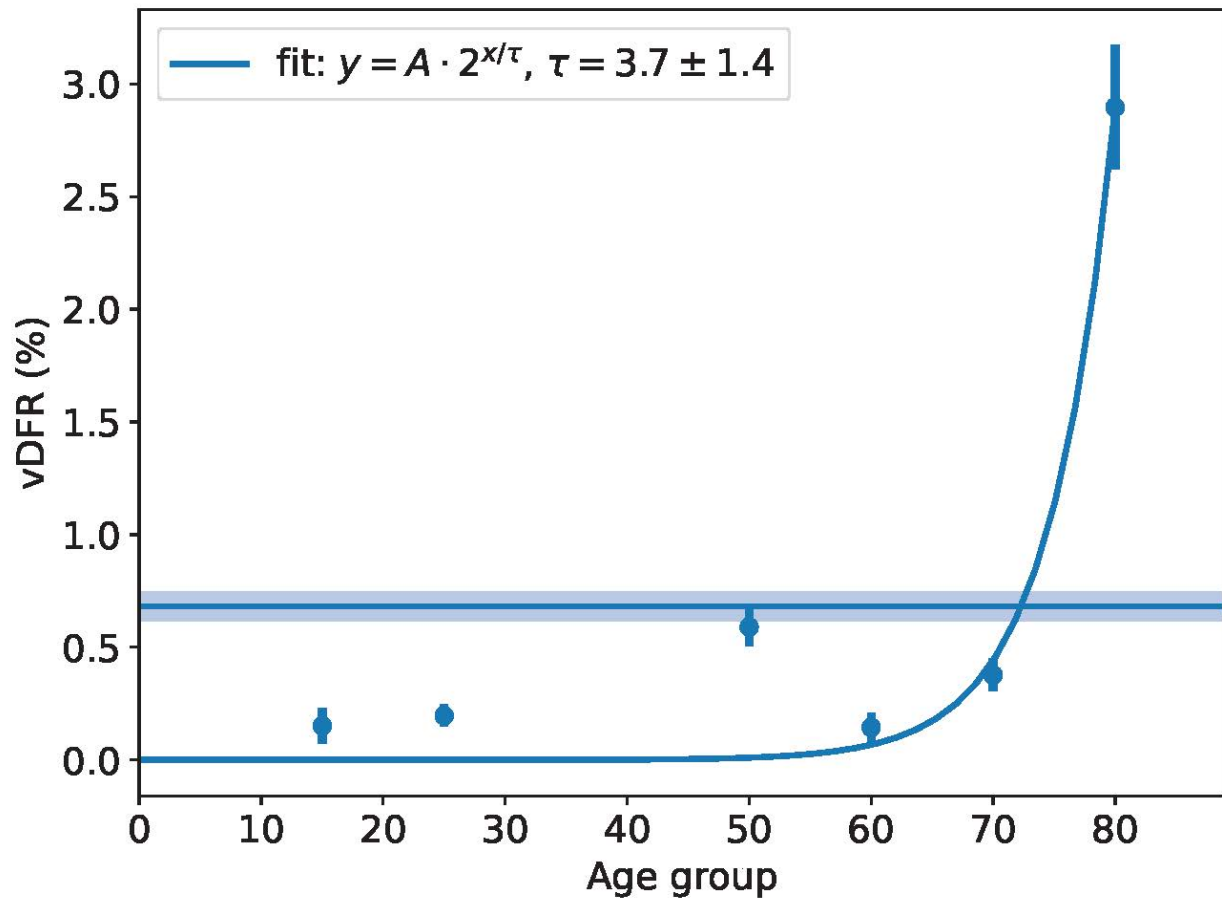
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Czechia (CZ)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

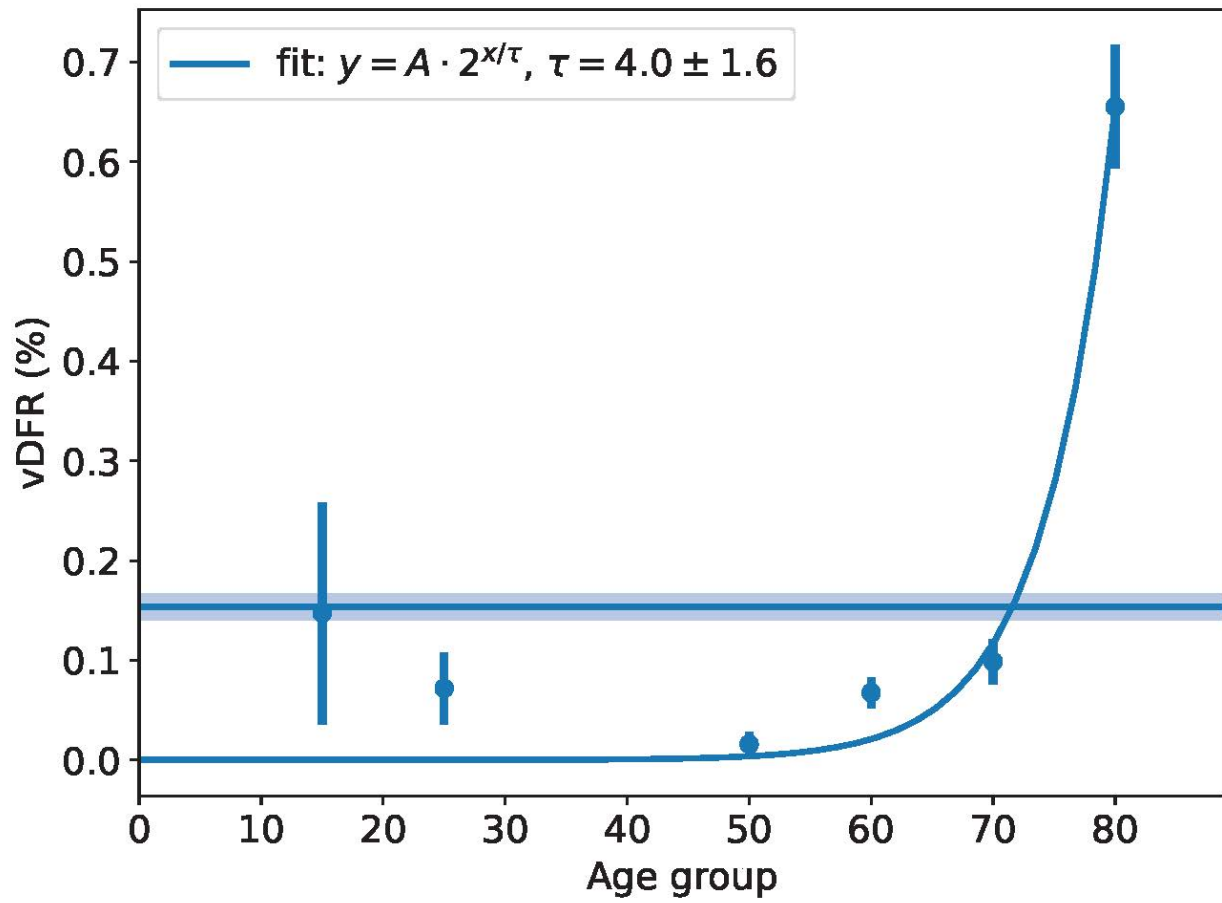
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Denmark (DK)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

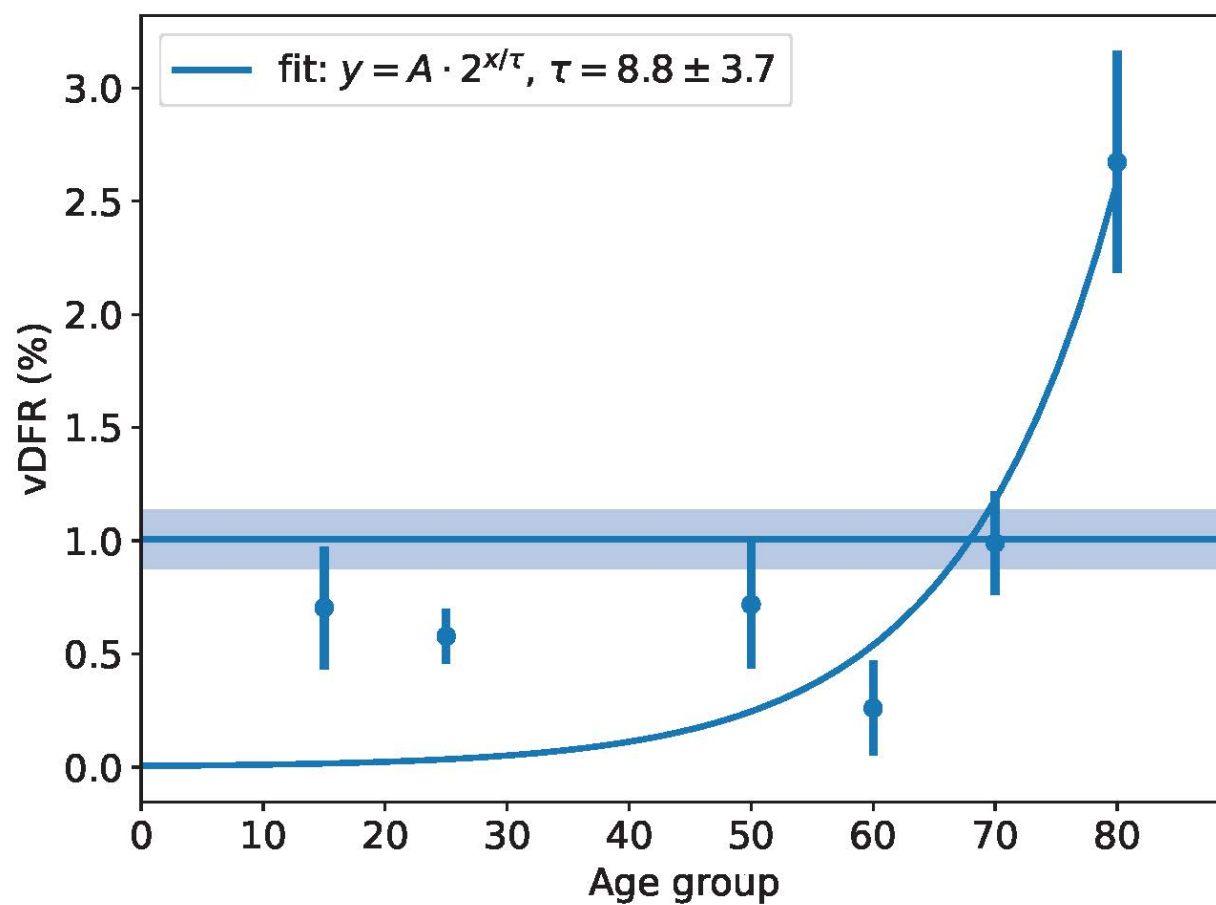
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Estonia (EE)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

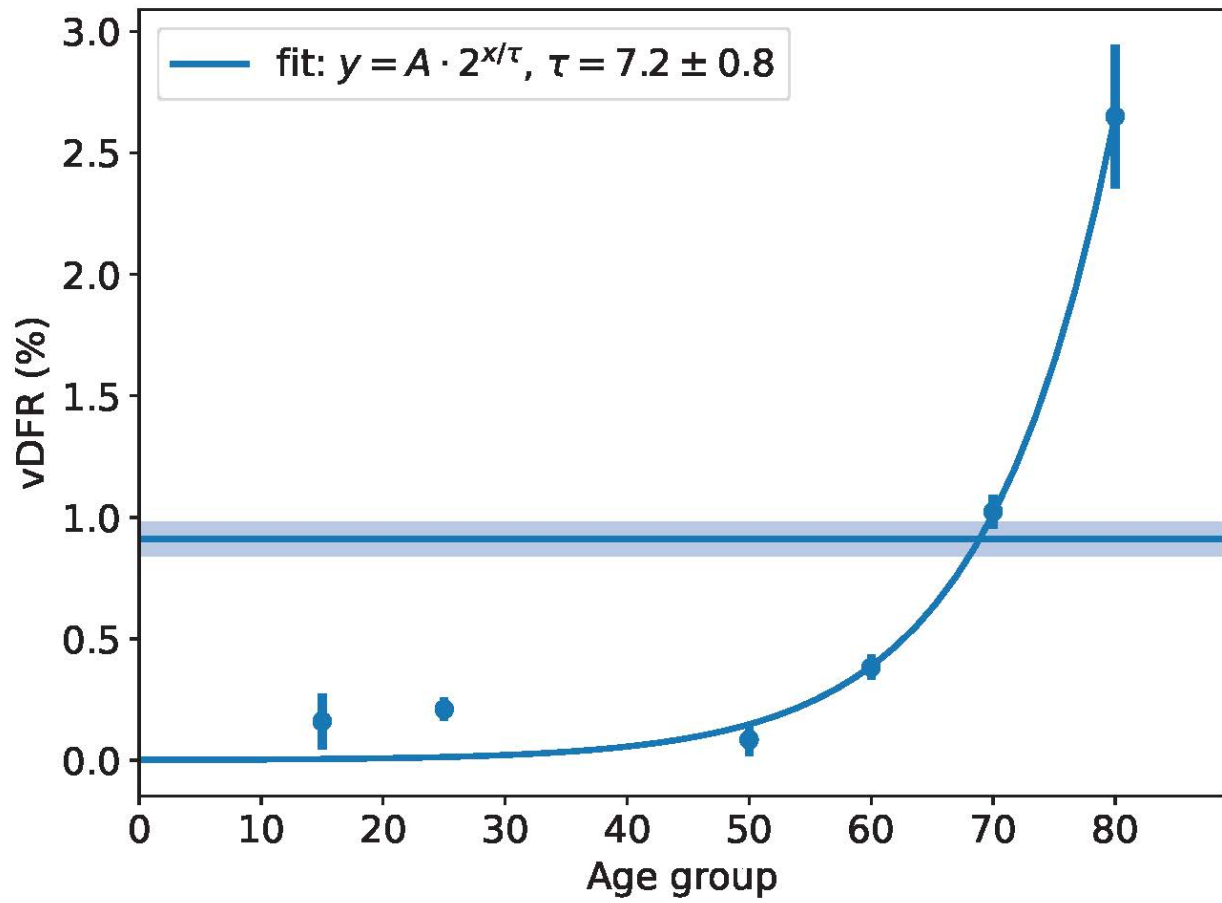
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Greece (EL)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

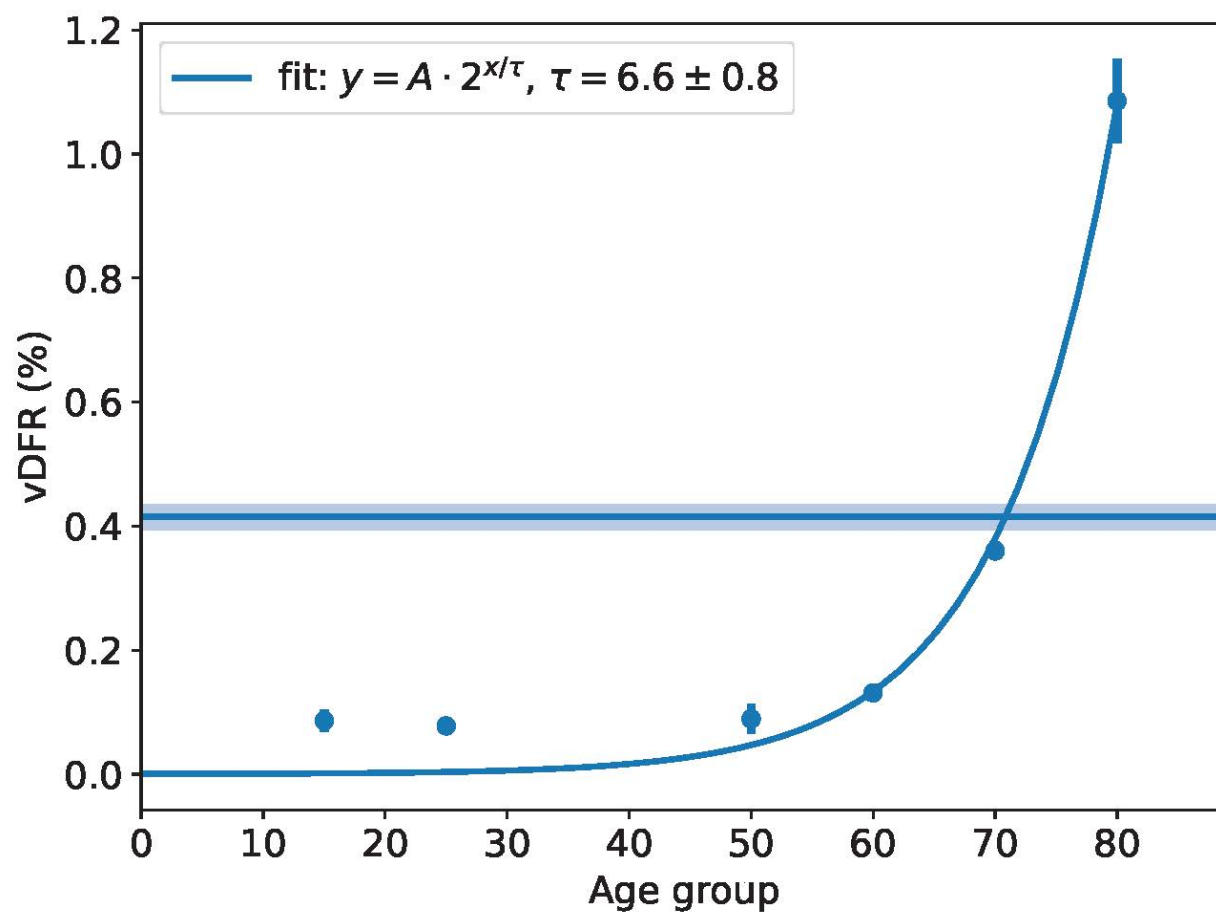
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Spain (ES)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

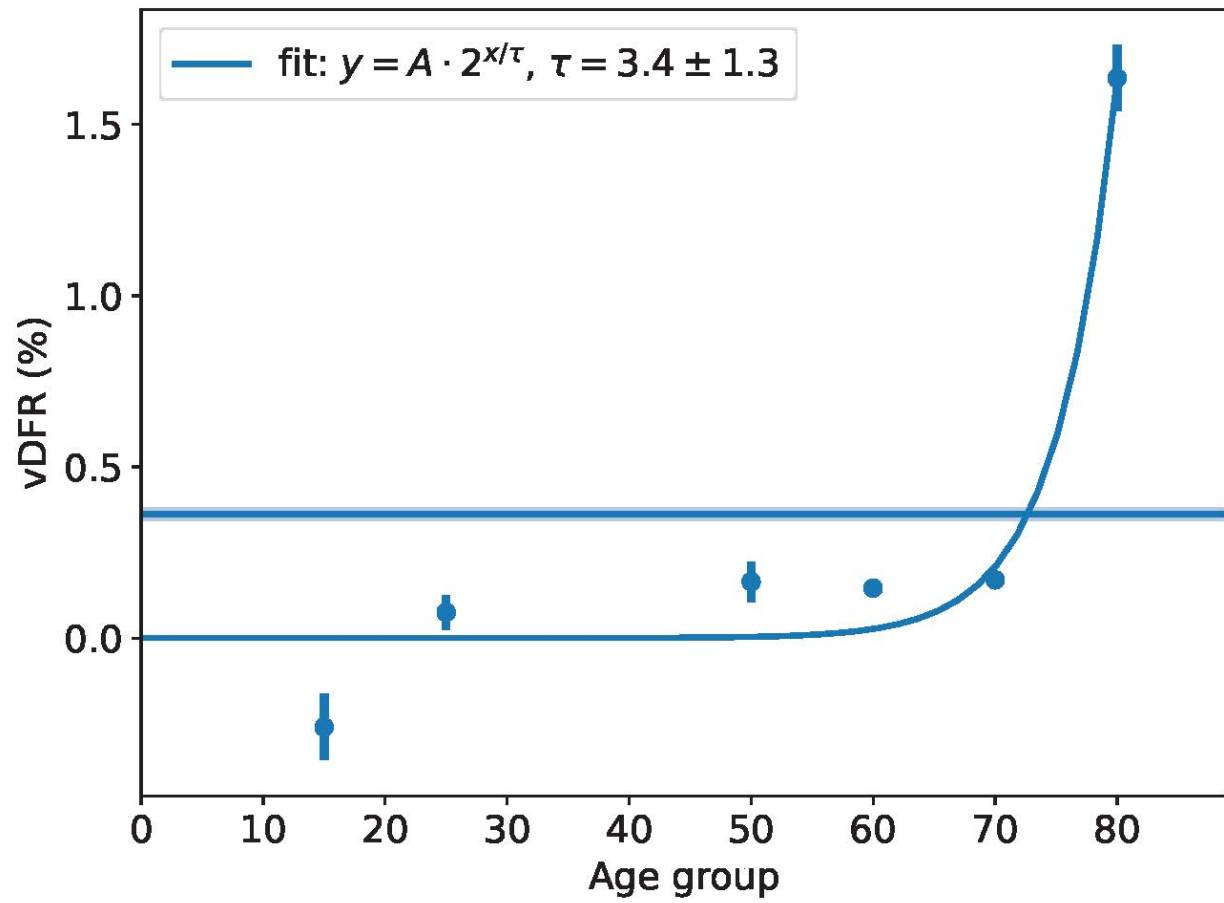
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Finland (FI)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

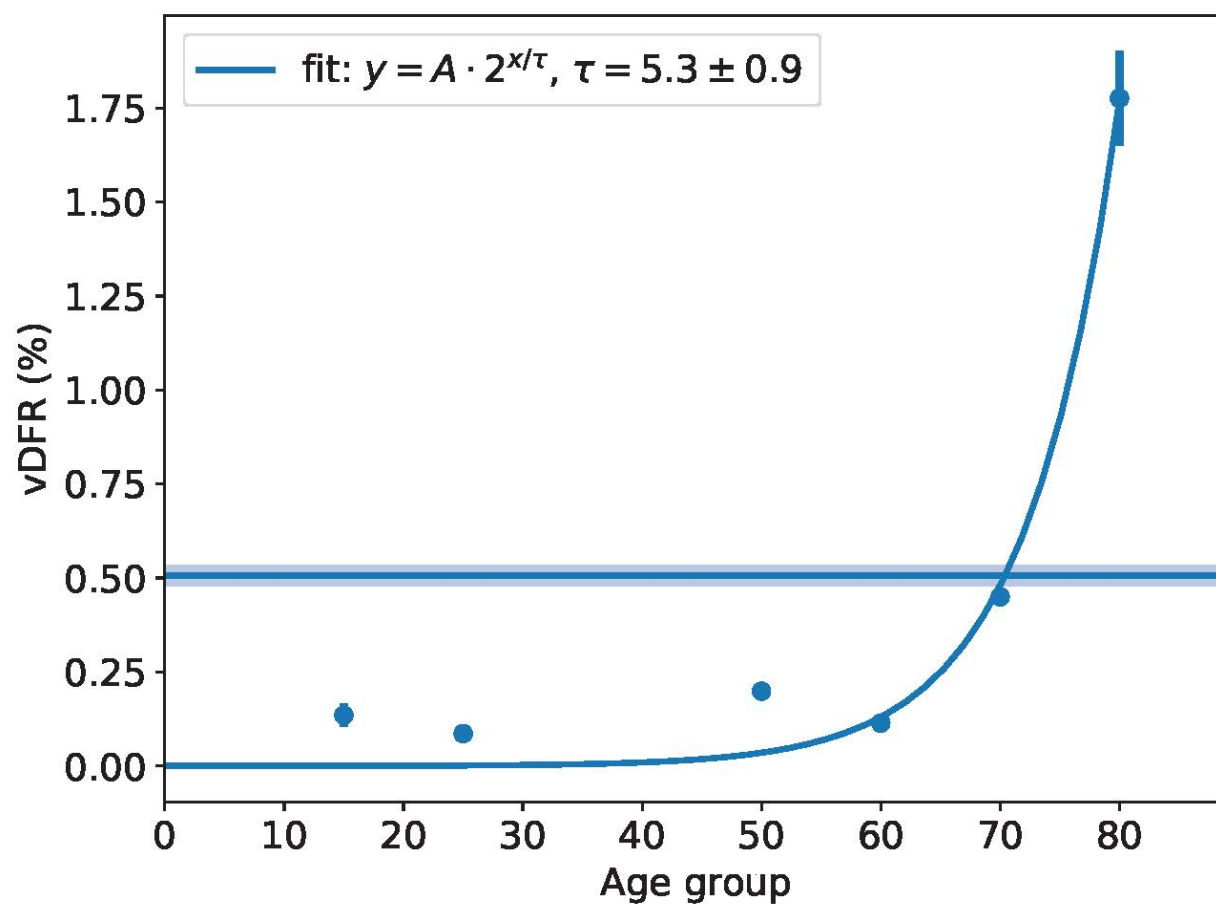
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



France (FR)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

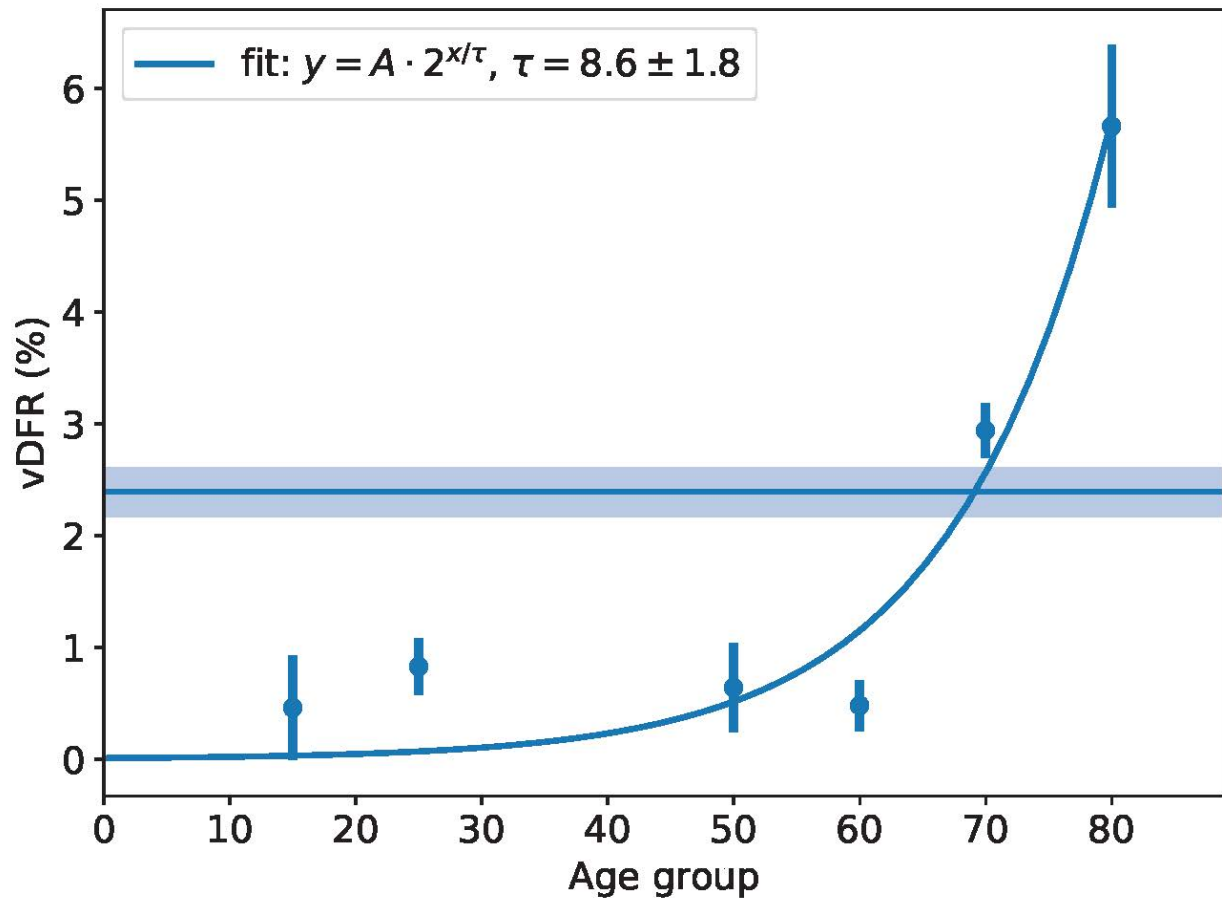
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Croatia (HR)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

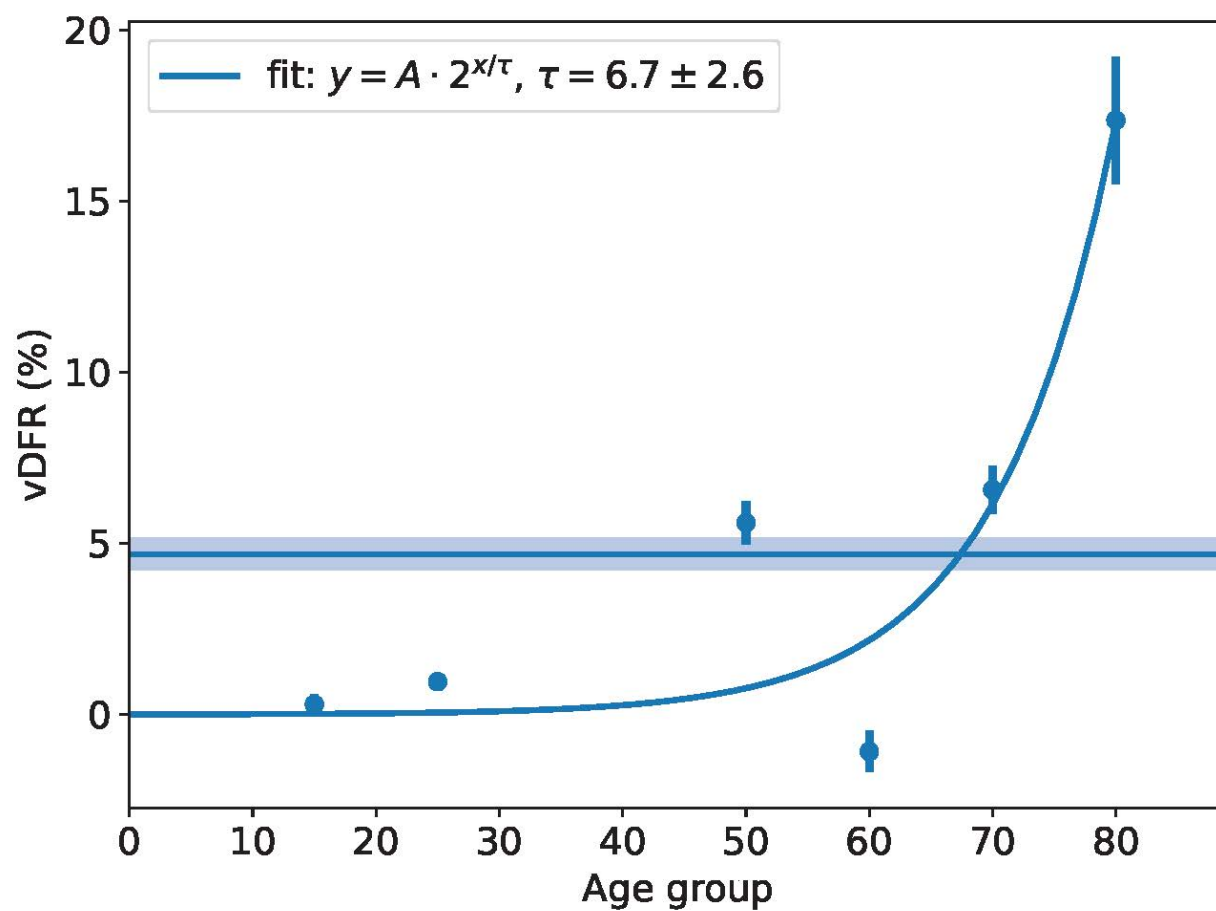
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Hungary (HU)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

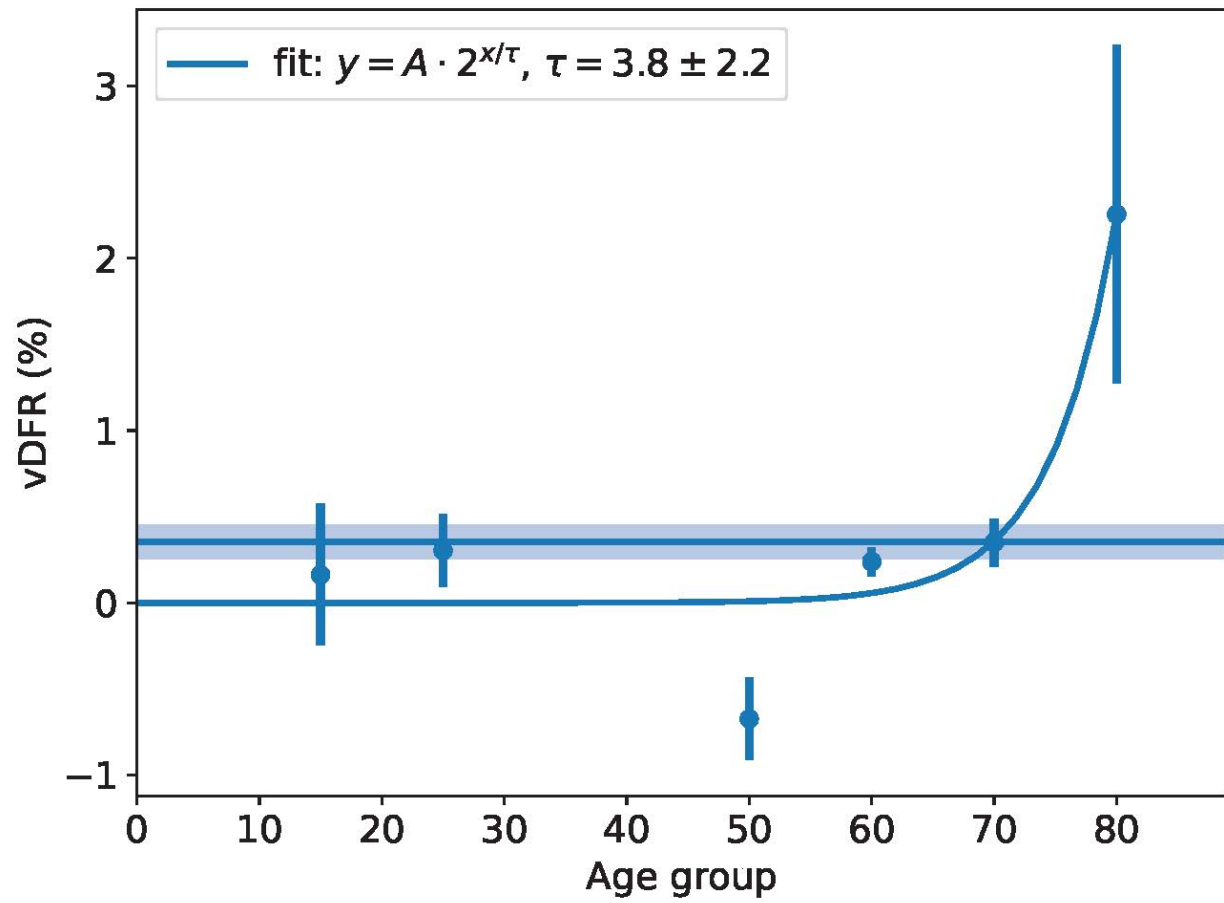
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Iceland (IS)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

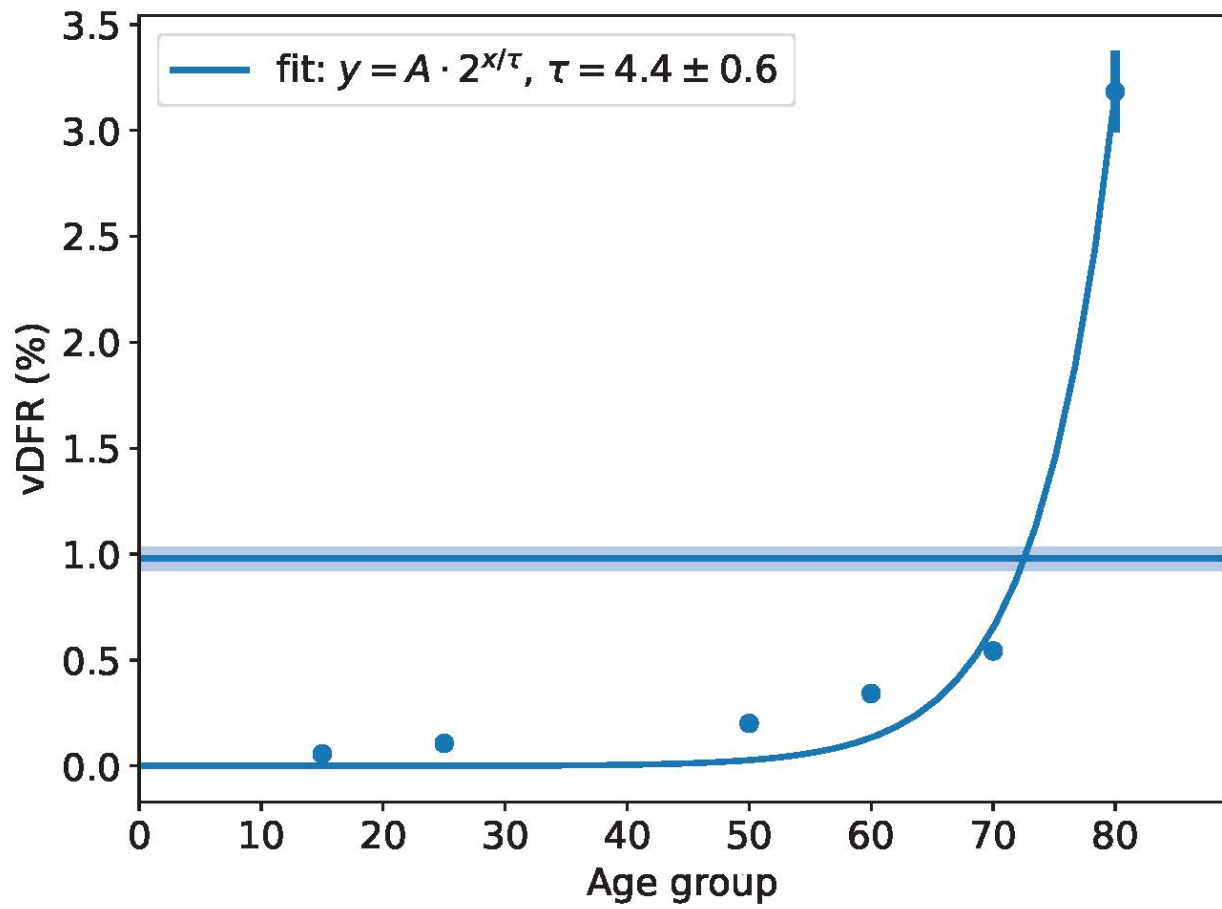
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Italy (IT)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

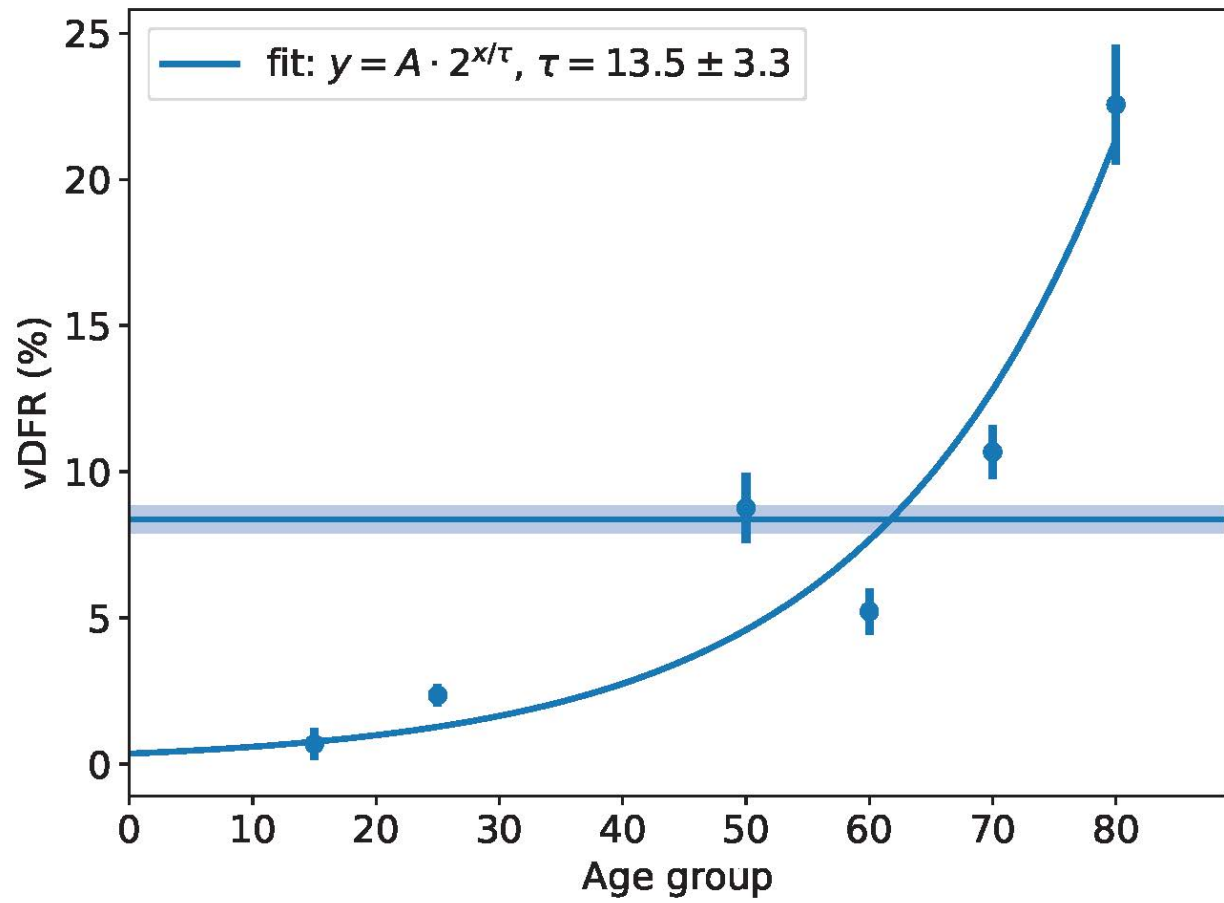
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Lithuania (LT)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

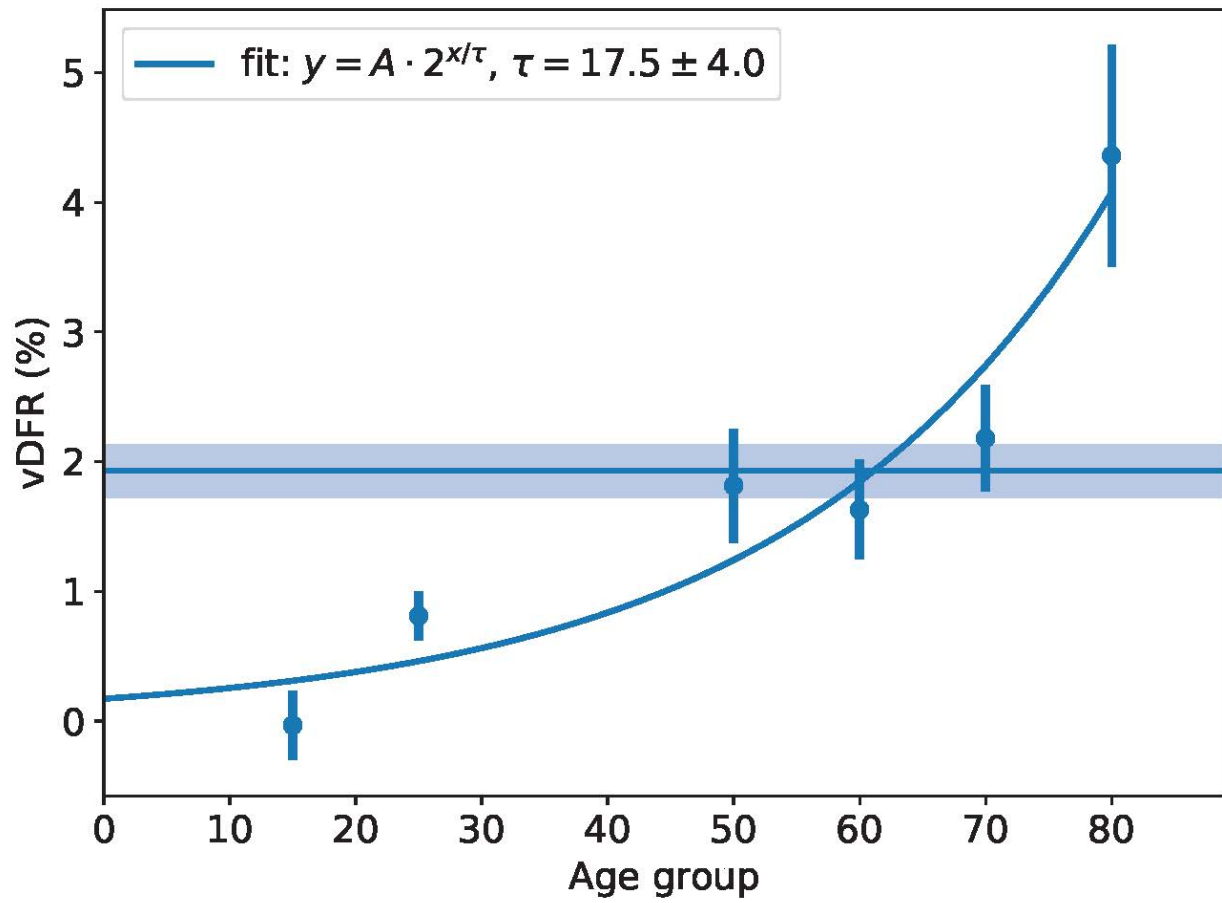
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Latvia (LV)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

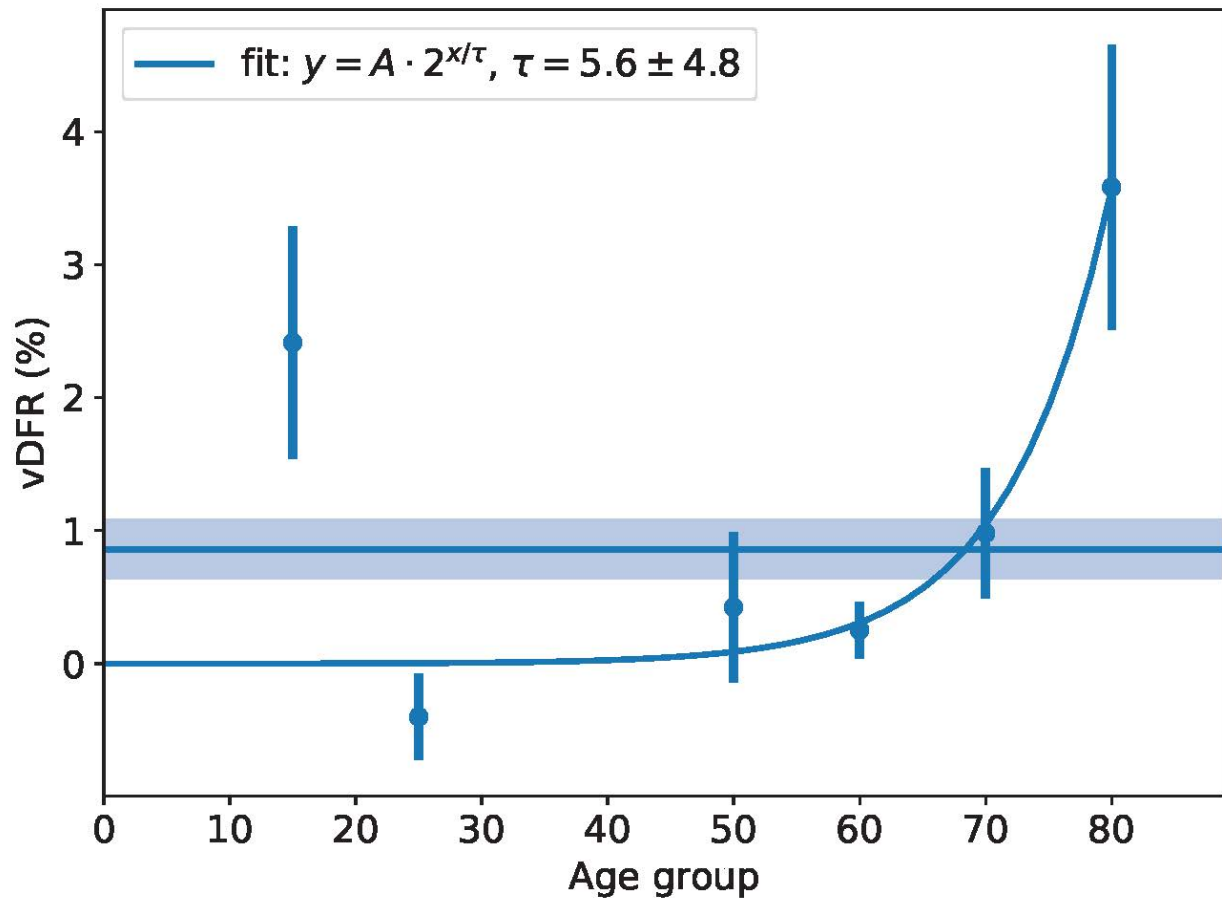
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Malta (MT)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

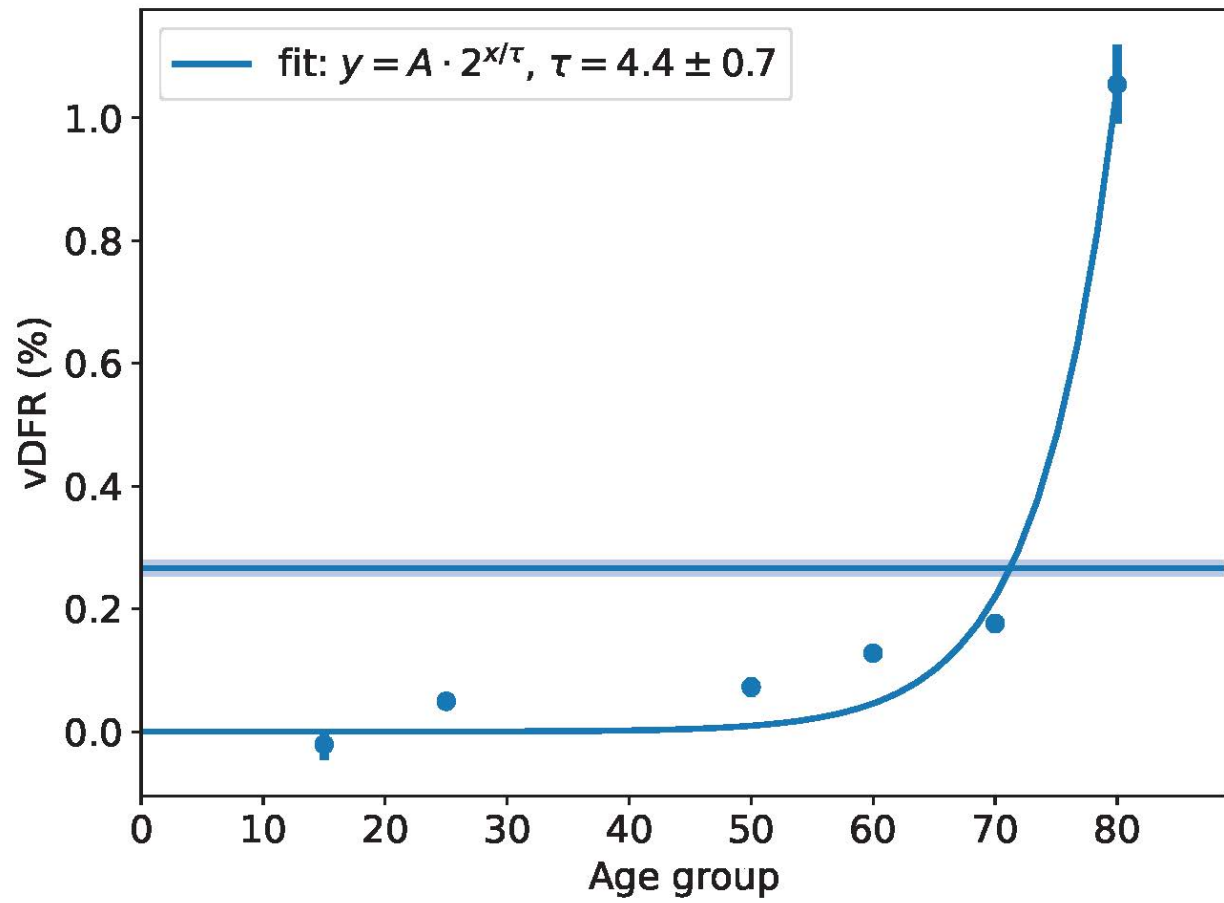
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Netherlands (NL)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

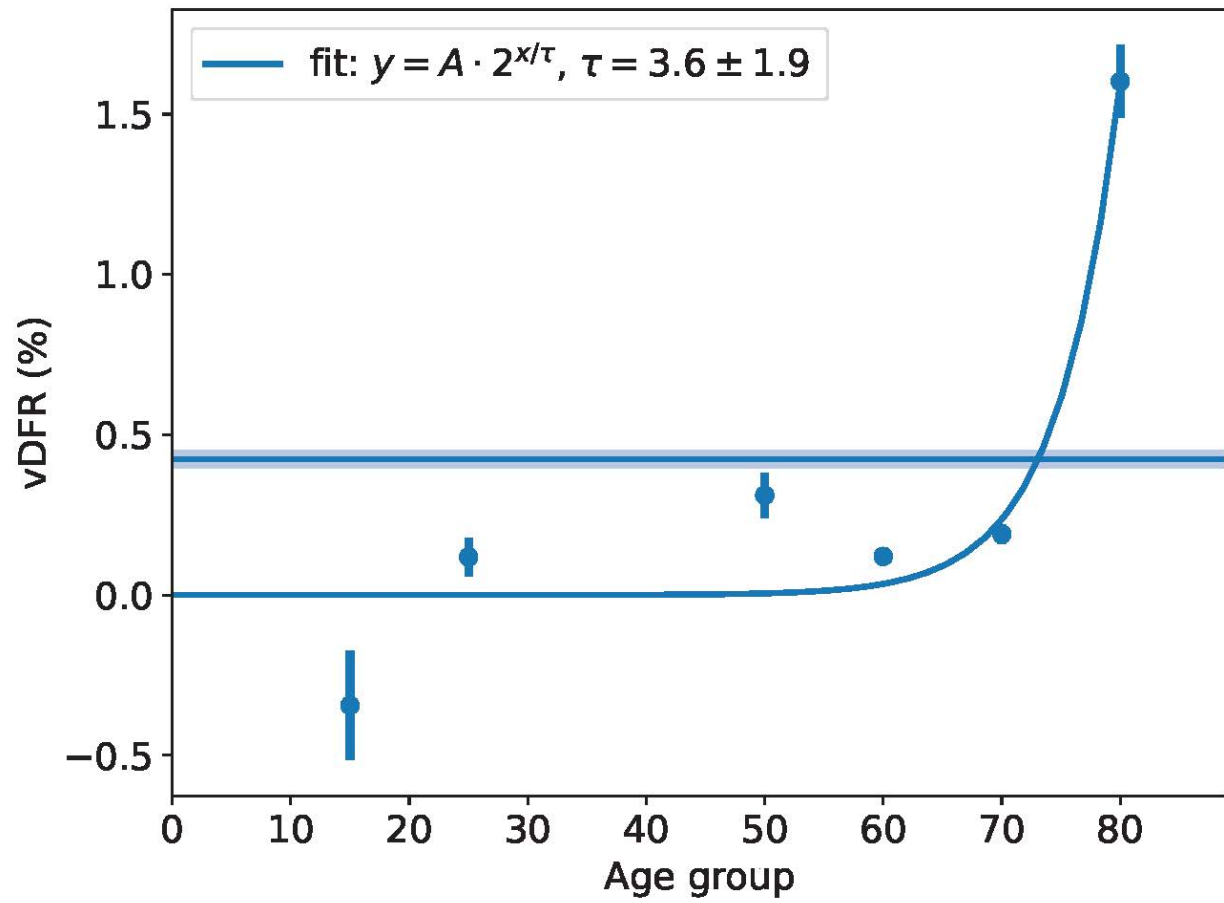
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Norway (NO)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

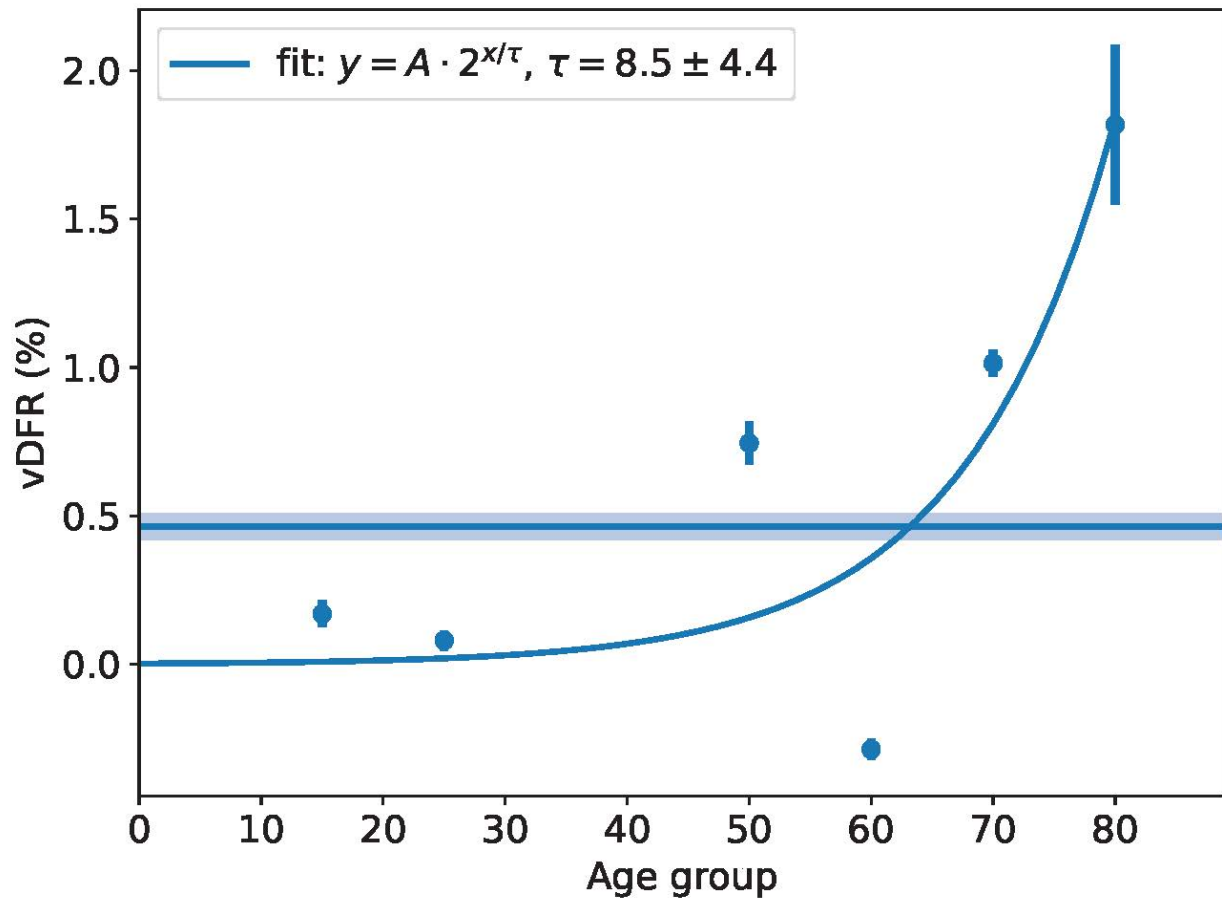
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Poland (PL)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

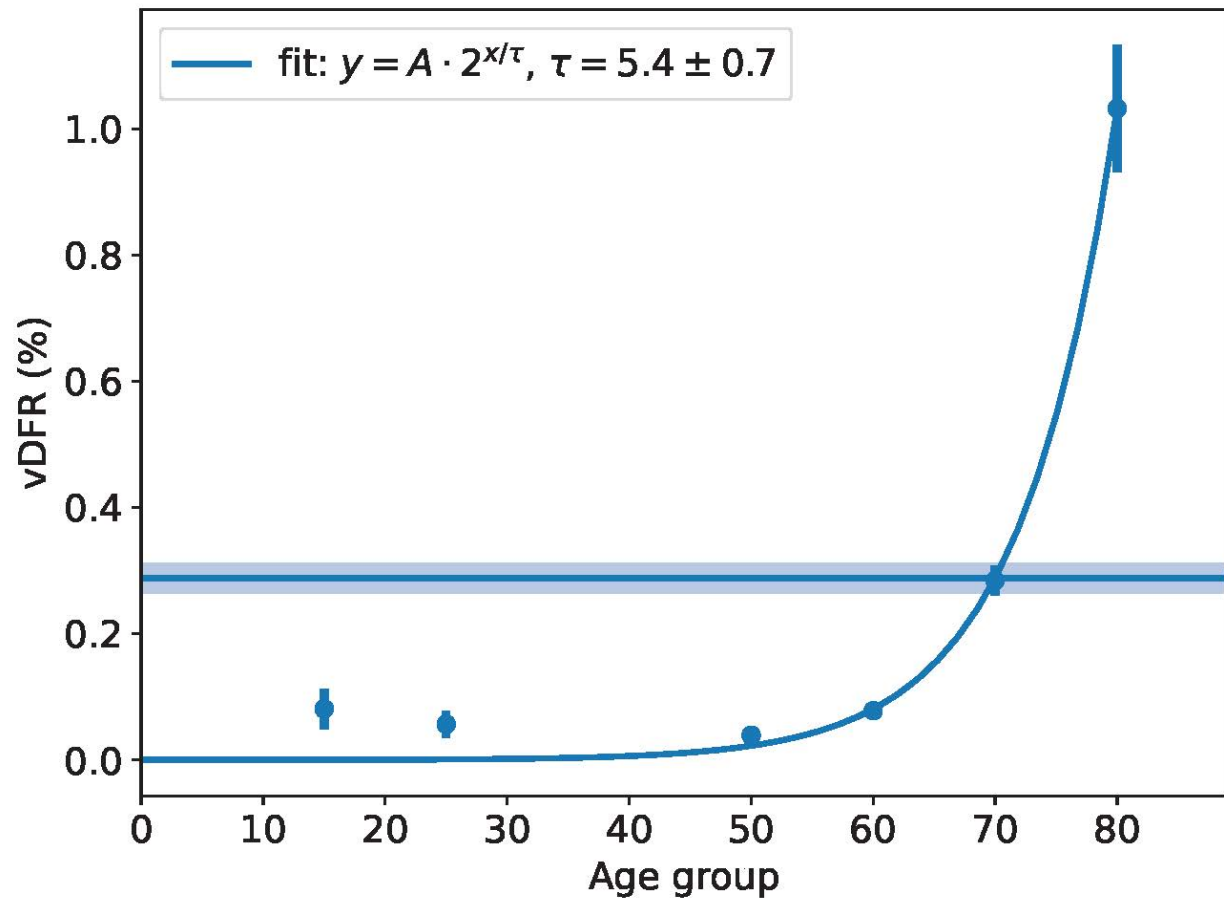
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Portugal (PT)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

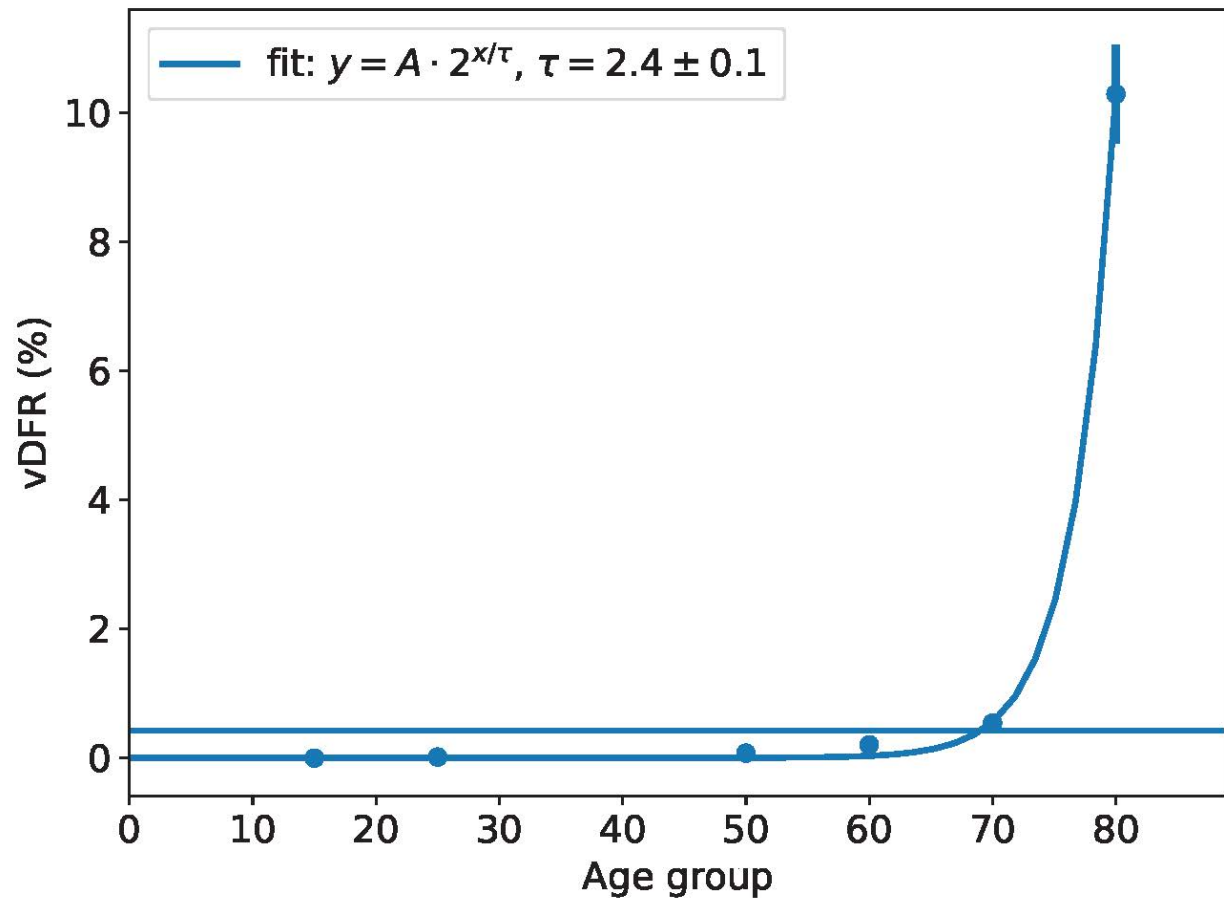
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Sweden (SE)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

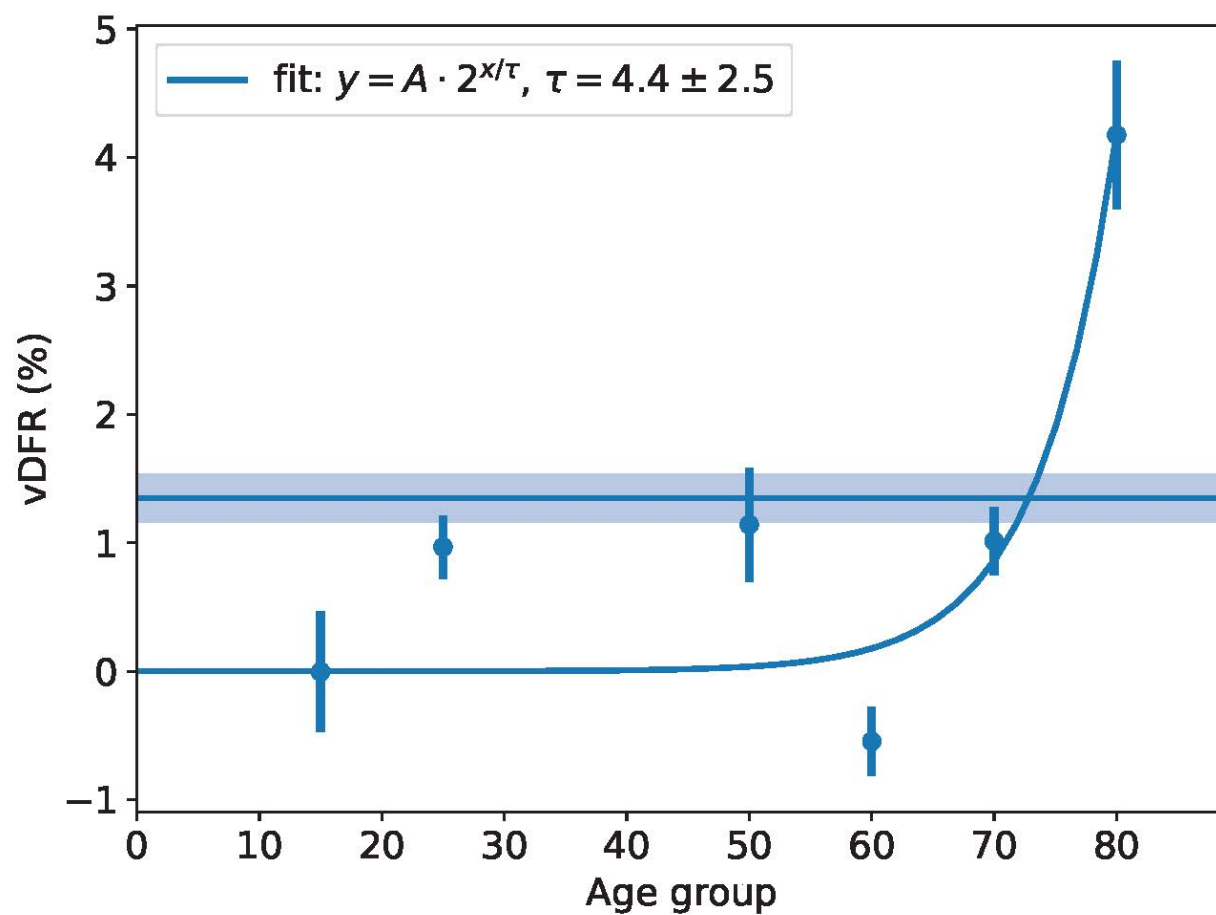
Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Slovenia (SI)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

Period (vax doses): 01-Jul-2022 to 31-Dec-2022



Slovakia (SK)

Period (excess deaths): 01-Jul-2022 to 31-Dec-2022

Period (vax doses): 01-Jul-2022 to 31-Dec-2022

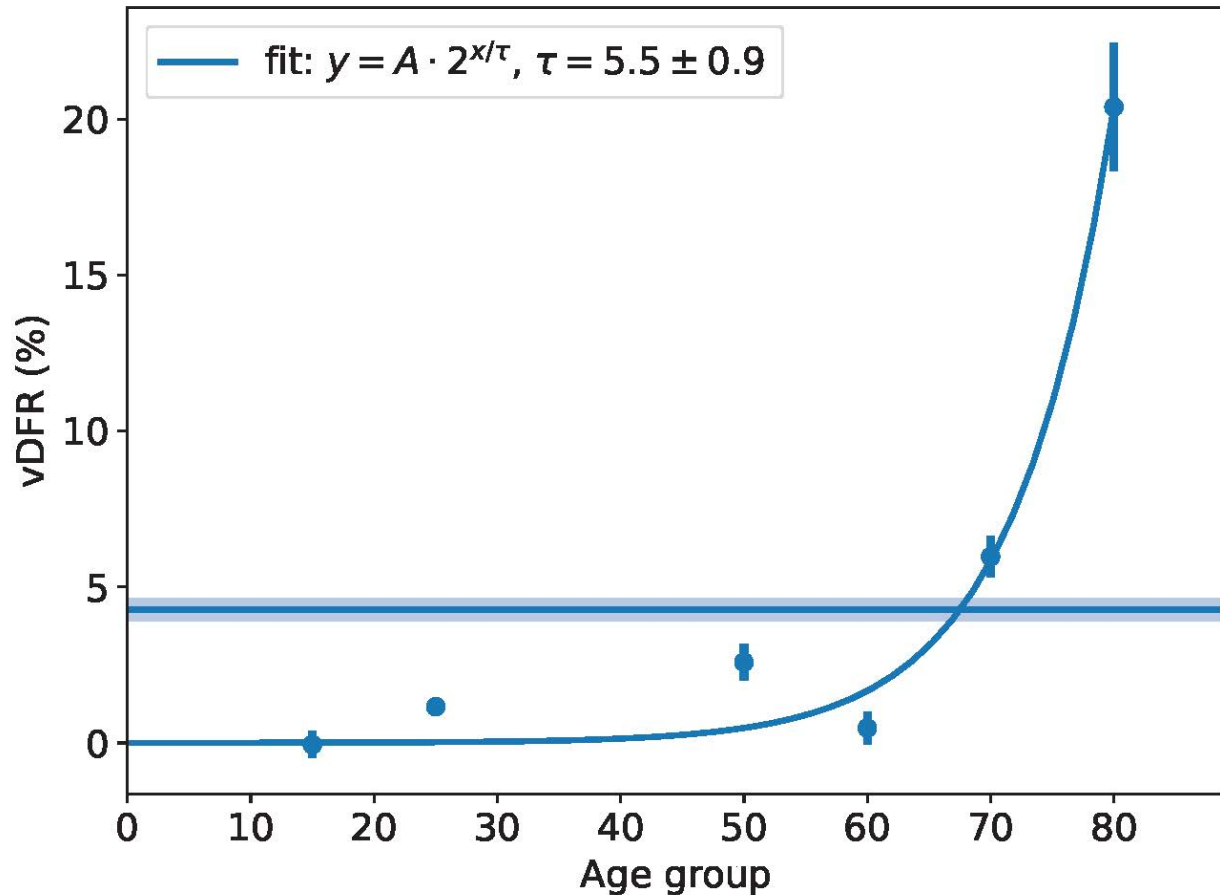


Figure 56. Population-wide risk of death per COVID-19 vaccine injection (vDFR) versus age, for the half year 2022-H2, in 25 European countries with sufficient data, with exponential fits, and all-ages value as a horizontal line. Fit parameters are given in the legend.

The exponential increase with age of the population-wide risk of death per COVID-19 vaccine injection (vDFR) is consistent with the hypothesis that the injection has a greater lethality in the most frail individuals already most susceptible to life threatening respiratory conditions (Section 5.12.3.3).

6 Conclusion

There is an overview in the Summary.

We are compelled to state that the public health establishment and its agents fundamentally caused all the excess mortality in the Covid period, via assaults on populations, harmful medical interventions and COVID-19 vaccine rollouts.

We conclude that nothing special would have occurred in terms of mortality had a pandemic not been declared and had the declaration not been acted upon.

(see appendixes after references)

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Rancourt - Hickey - Linard

Spatiotemporal variation of excess all-cause mortality in the world (125 countries) during the Covid period 2020-2023 regarding socio economic factors and public-health and medical interventions.

CORRELATION Research in the Public Interest, Report, 19 July 2024.

<https://correlation-canada.org/covid-excess-mortality-125-countries>

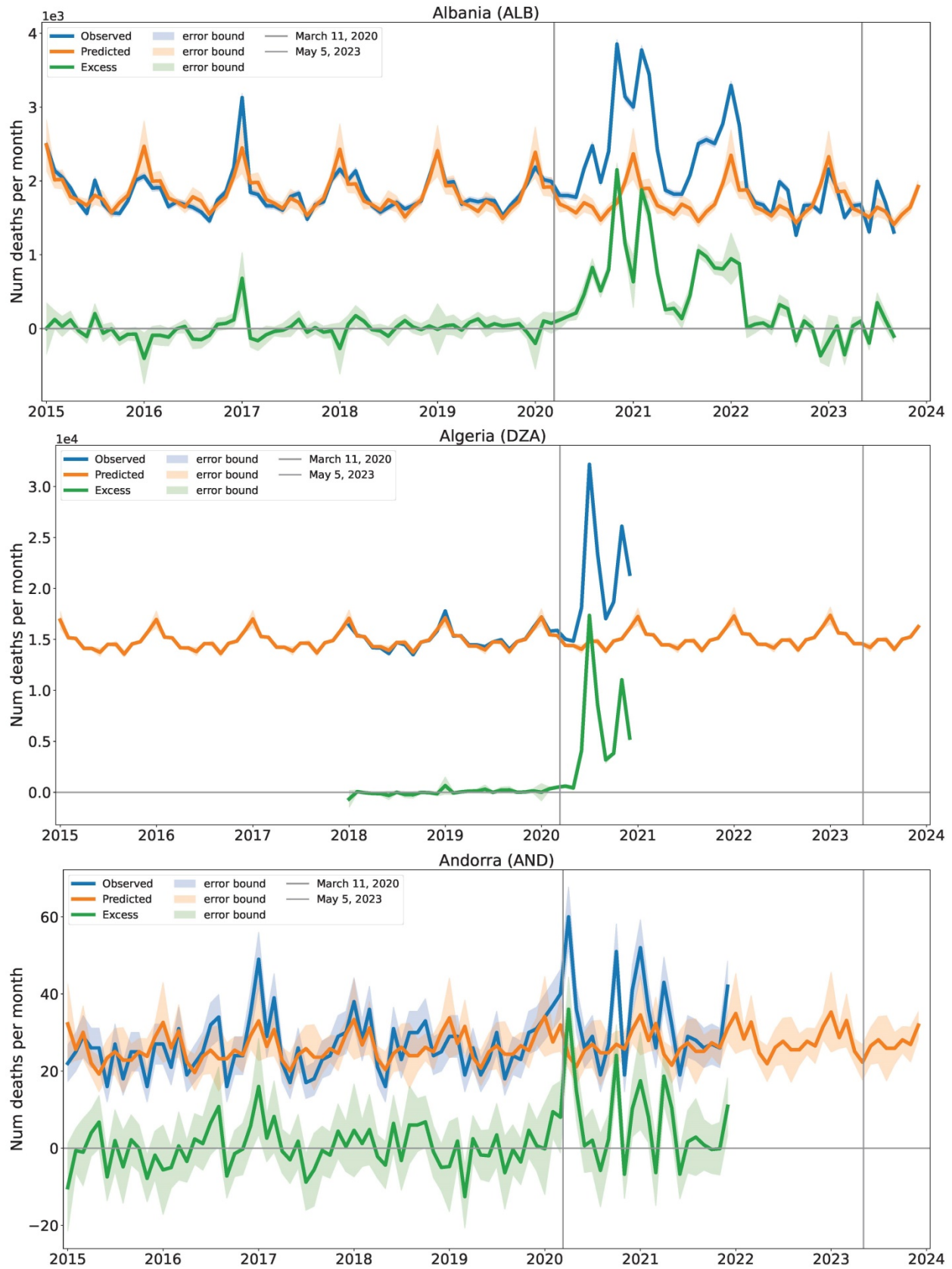
Appendix A: All-cause mortality and excess all-cause mortality in 125 countries, 2015-2023

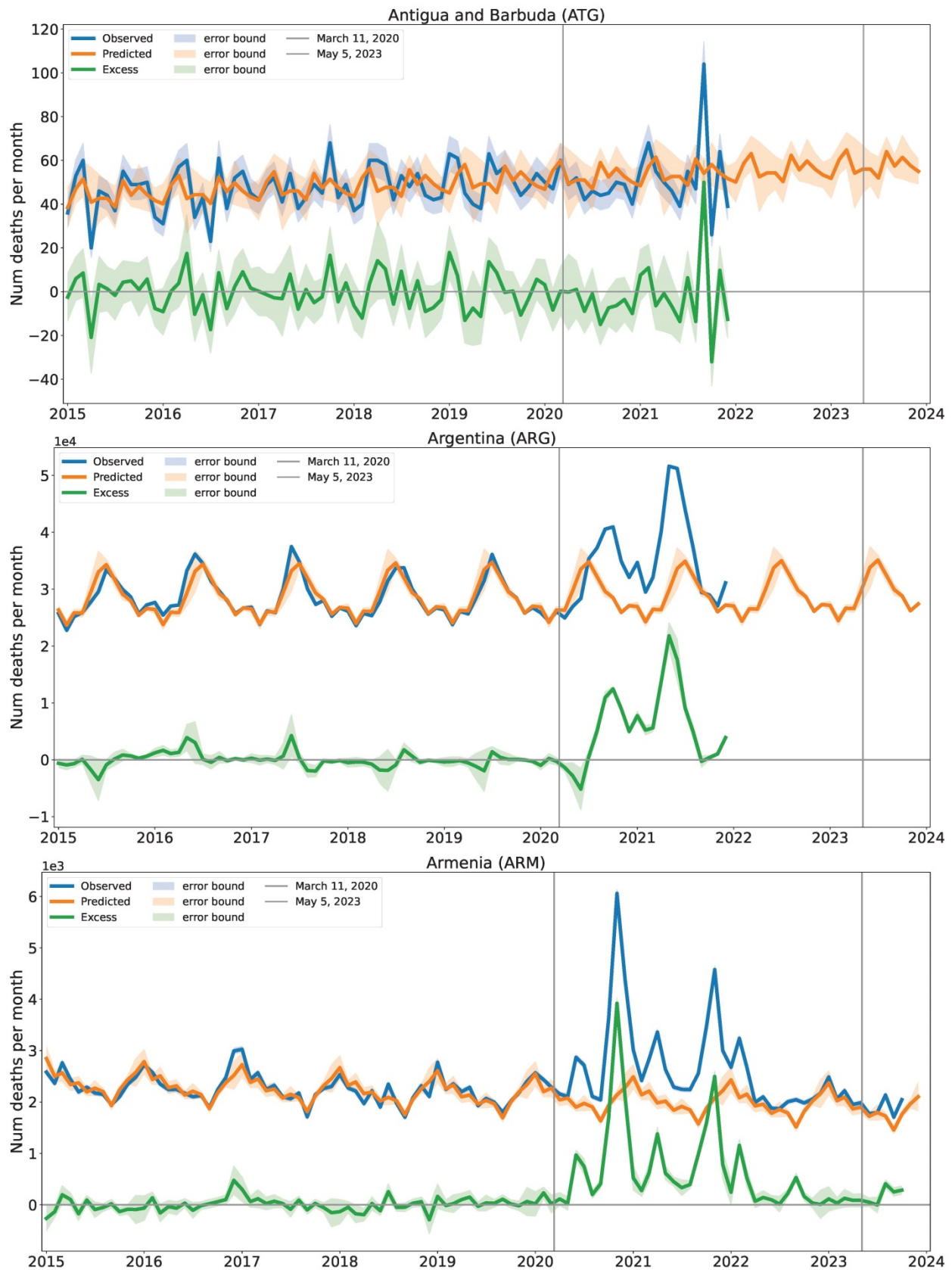
The figure in this Appendix has 125 consecutive panels, in alphabetical order of country name.

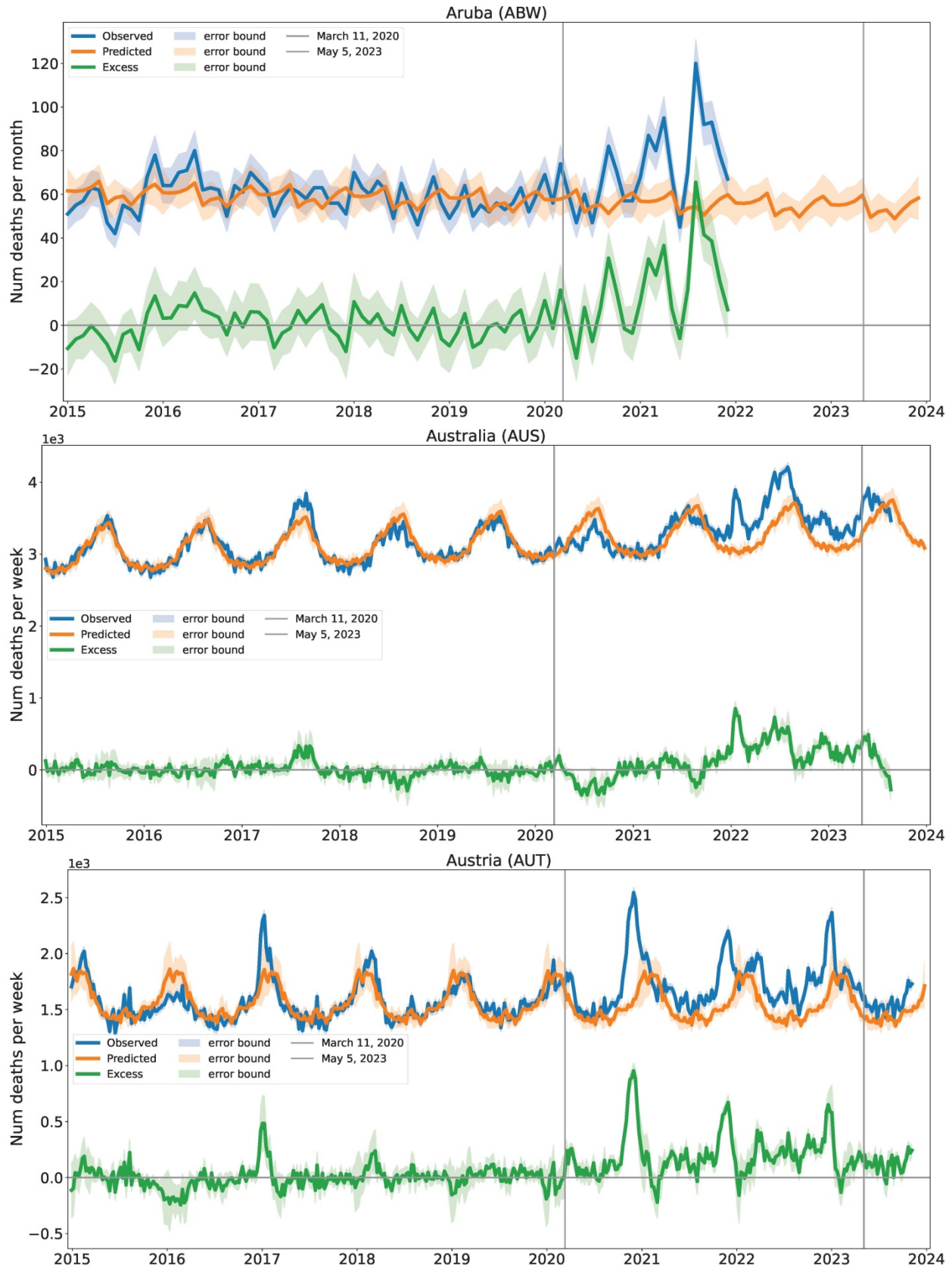
All-cause mortality by week or by month (bleu) and historic trend all-cause mortality by week or by month (orange) (top curves) and excess all-cause mortality by week or by month (bottom curves), with 1σ error bounds, for 125 countries (as labelled).

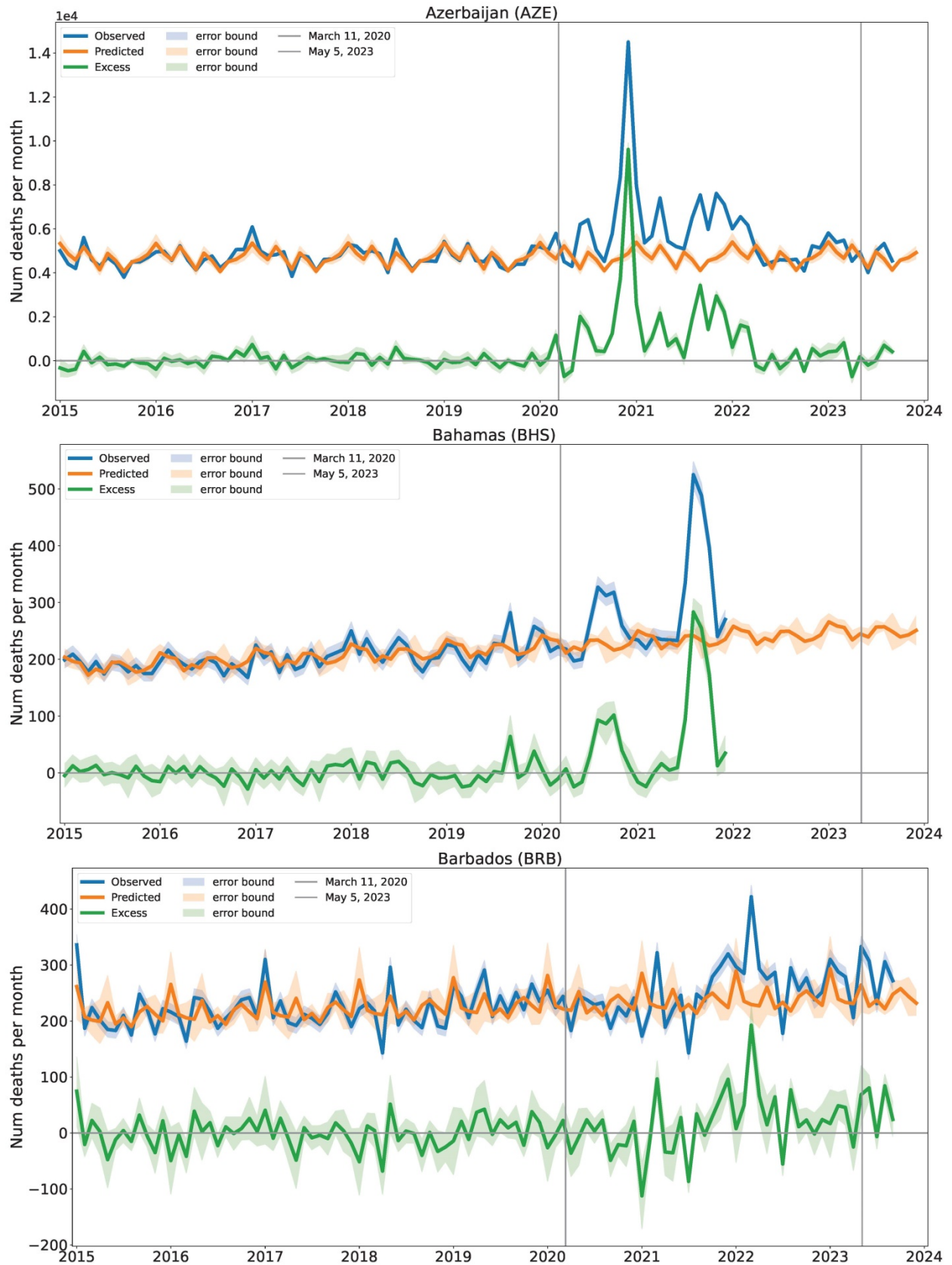
The vertical grey lines indicate the dates of 11 March 2020 (declared start of a pandemic) and 5 May 2023 (declared end of the declared pandemic).

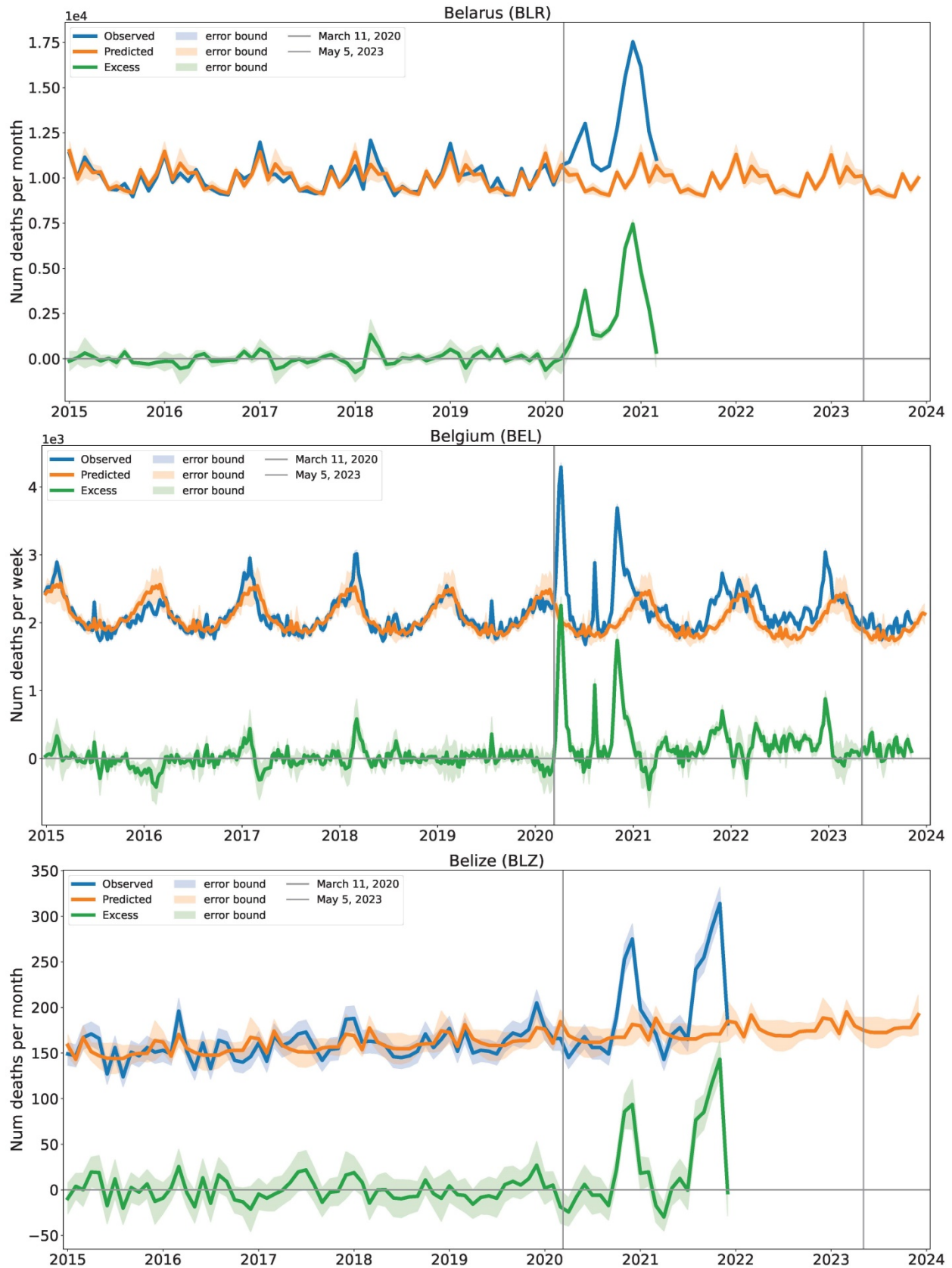
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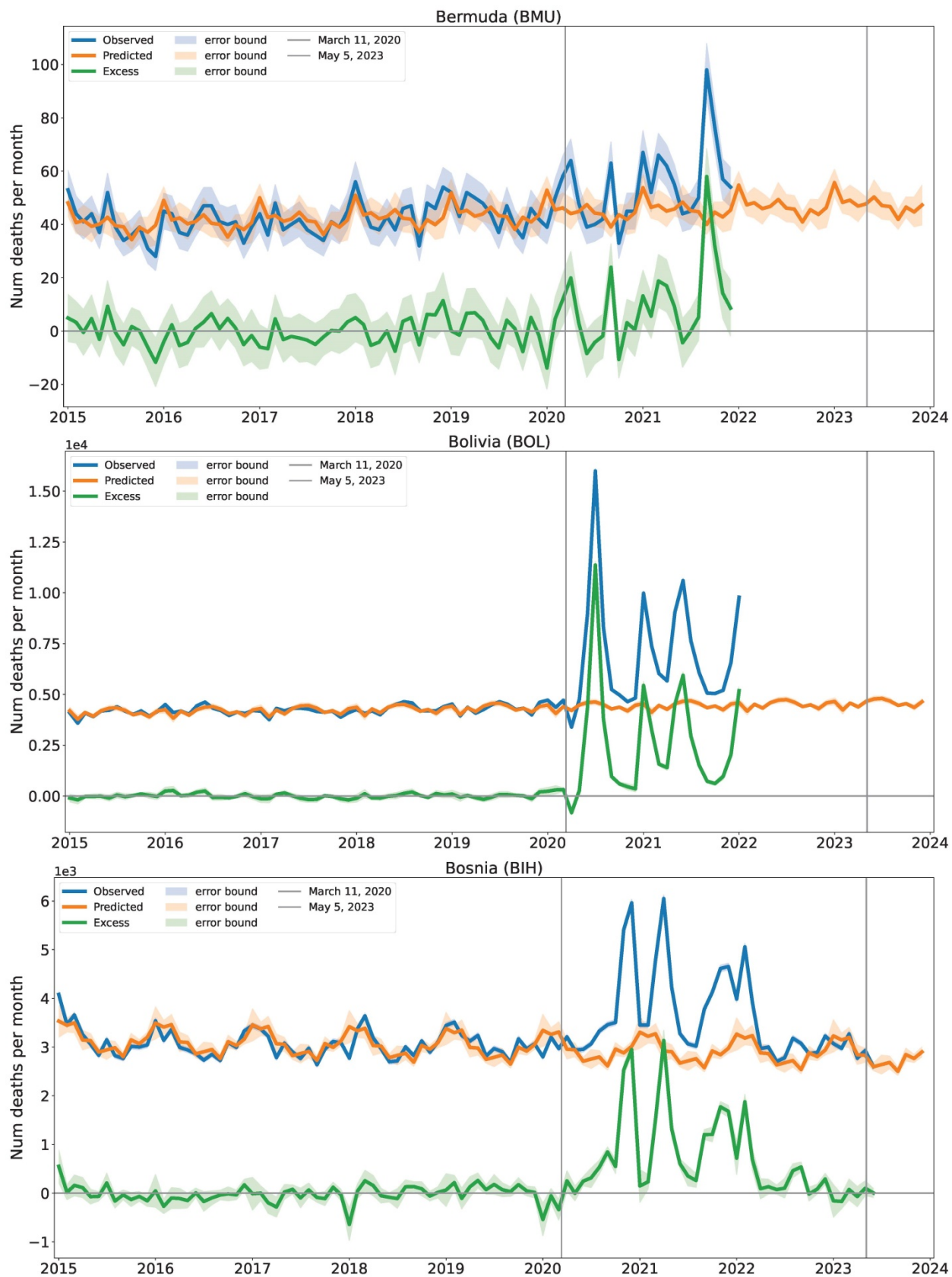


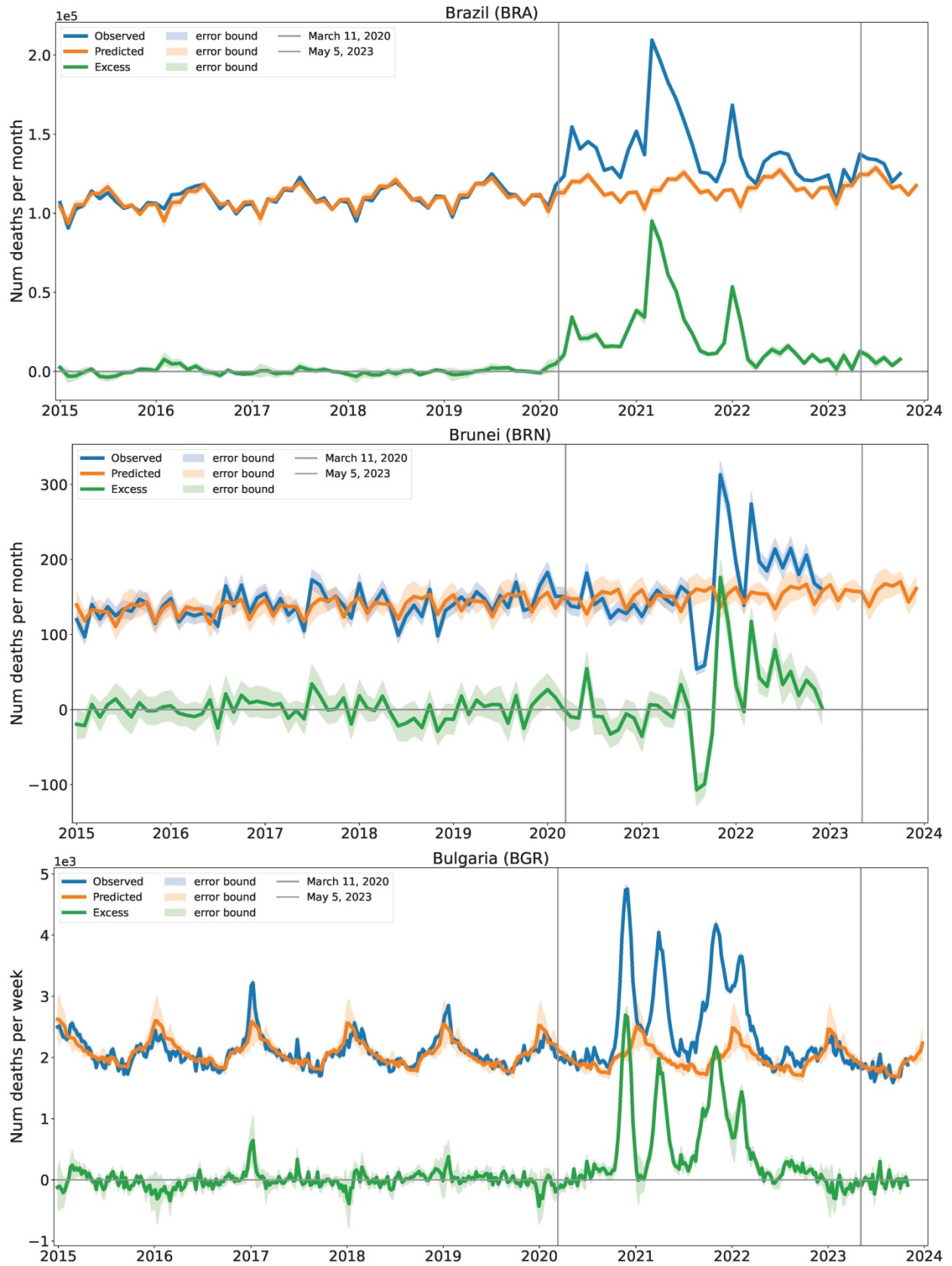


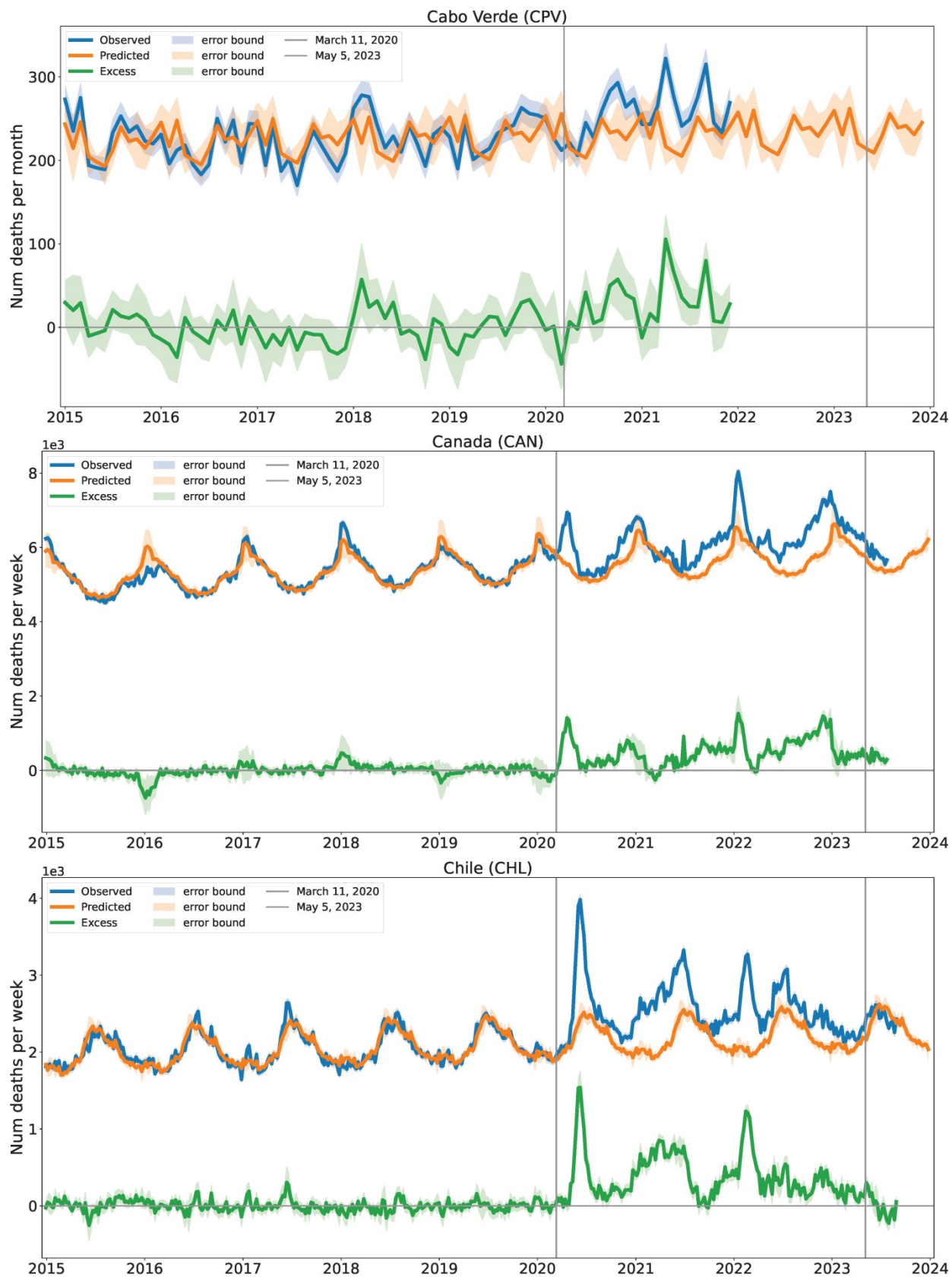


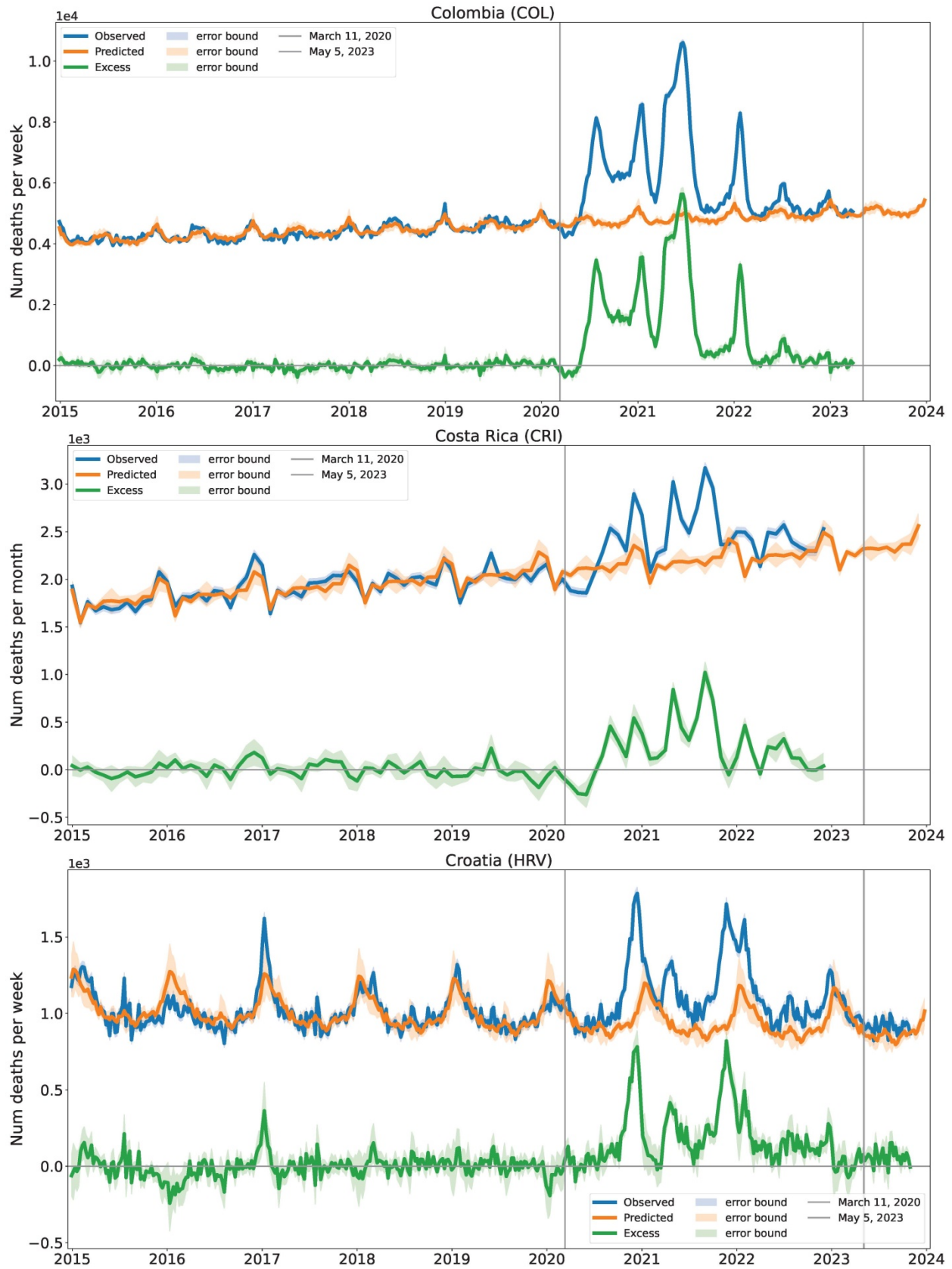


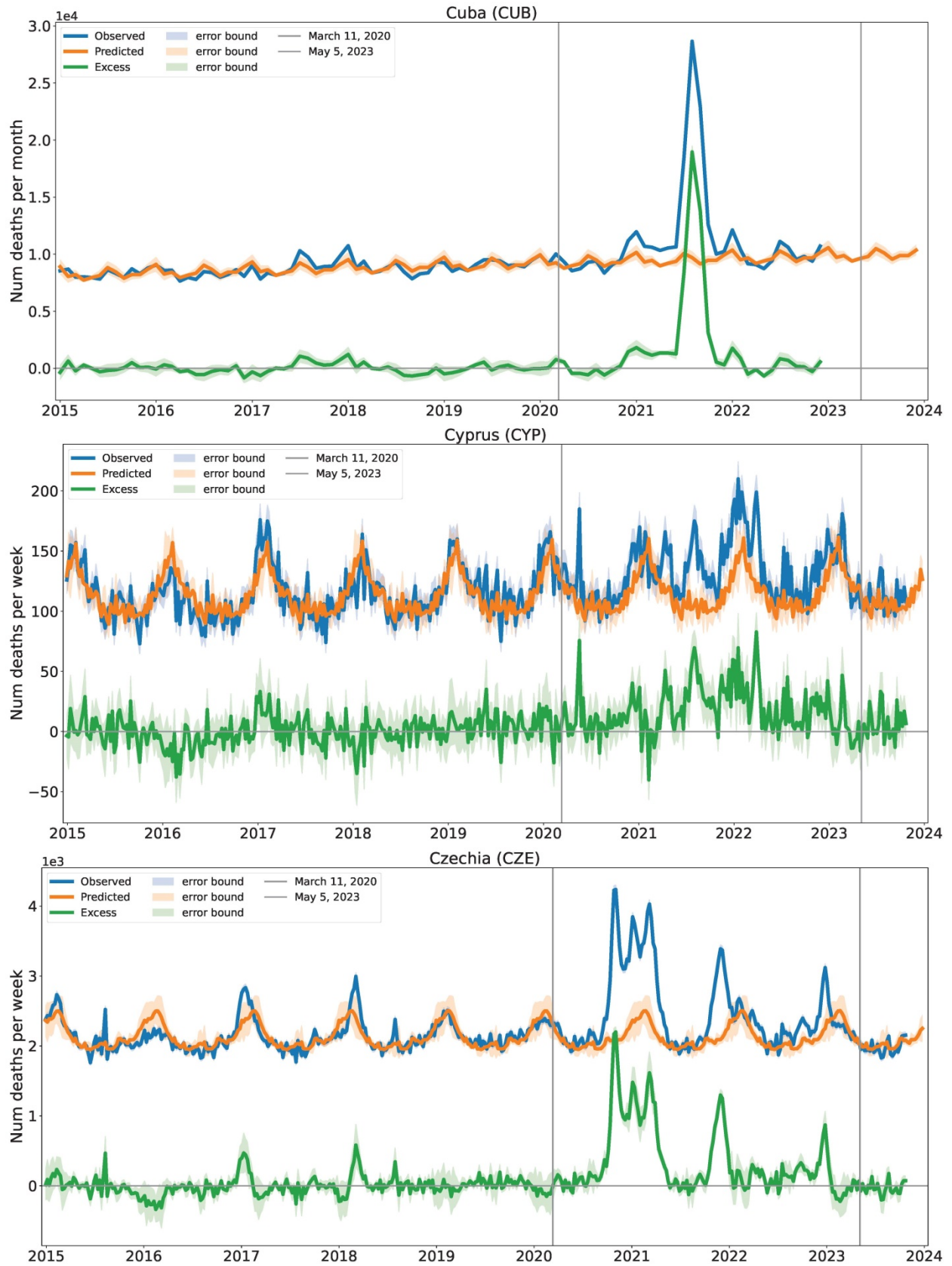


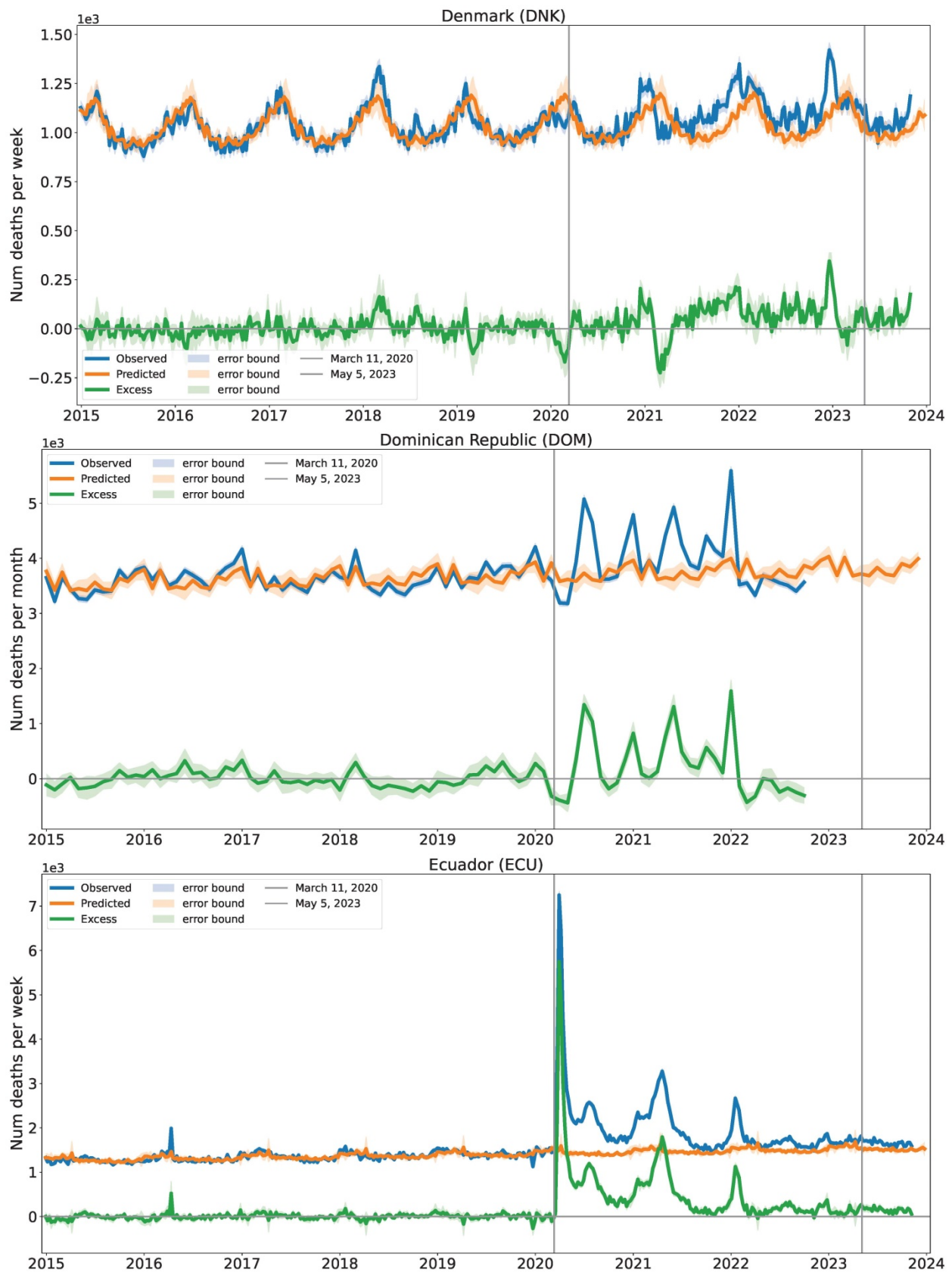


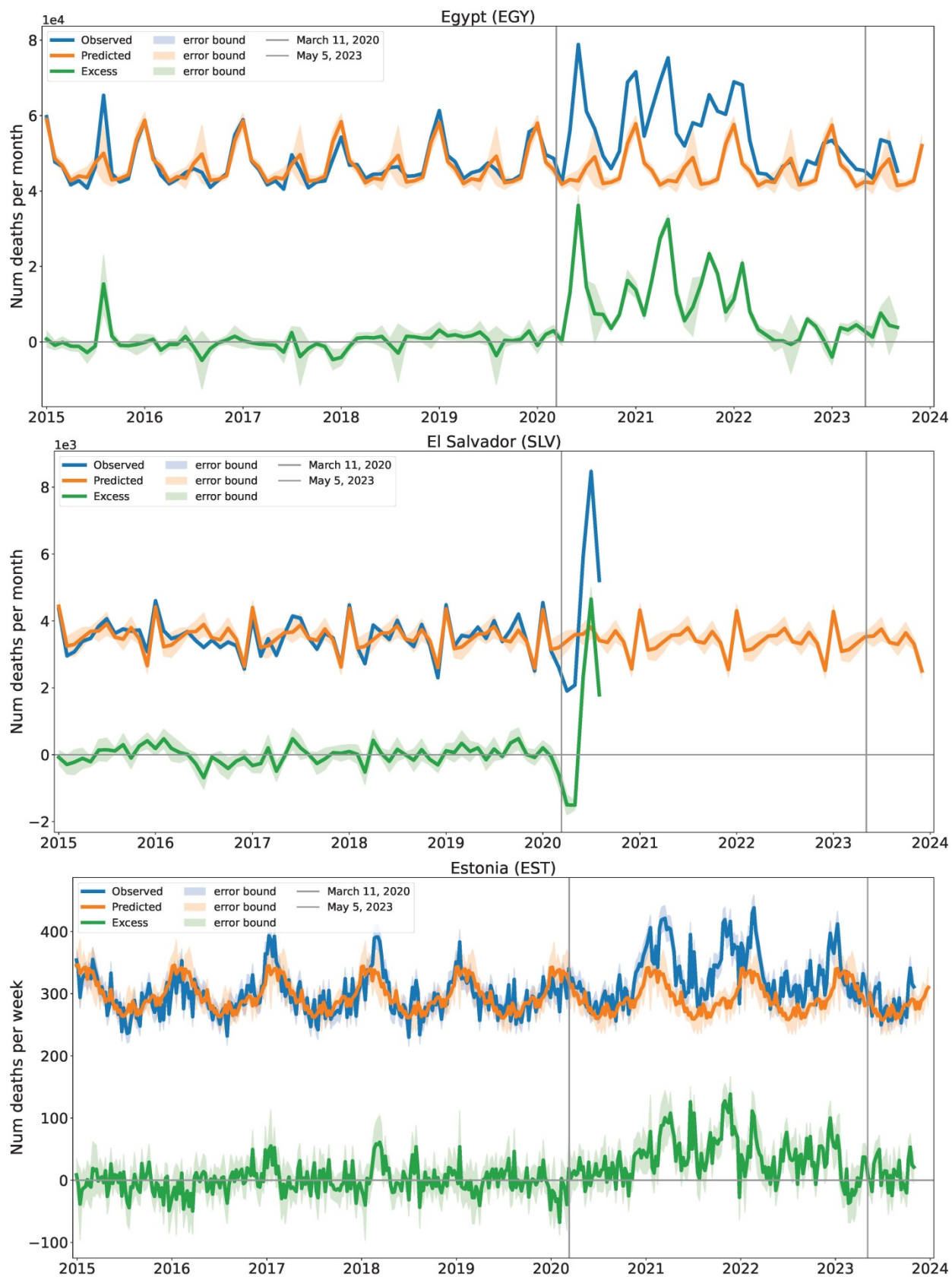


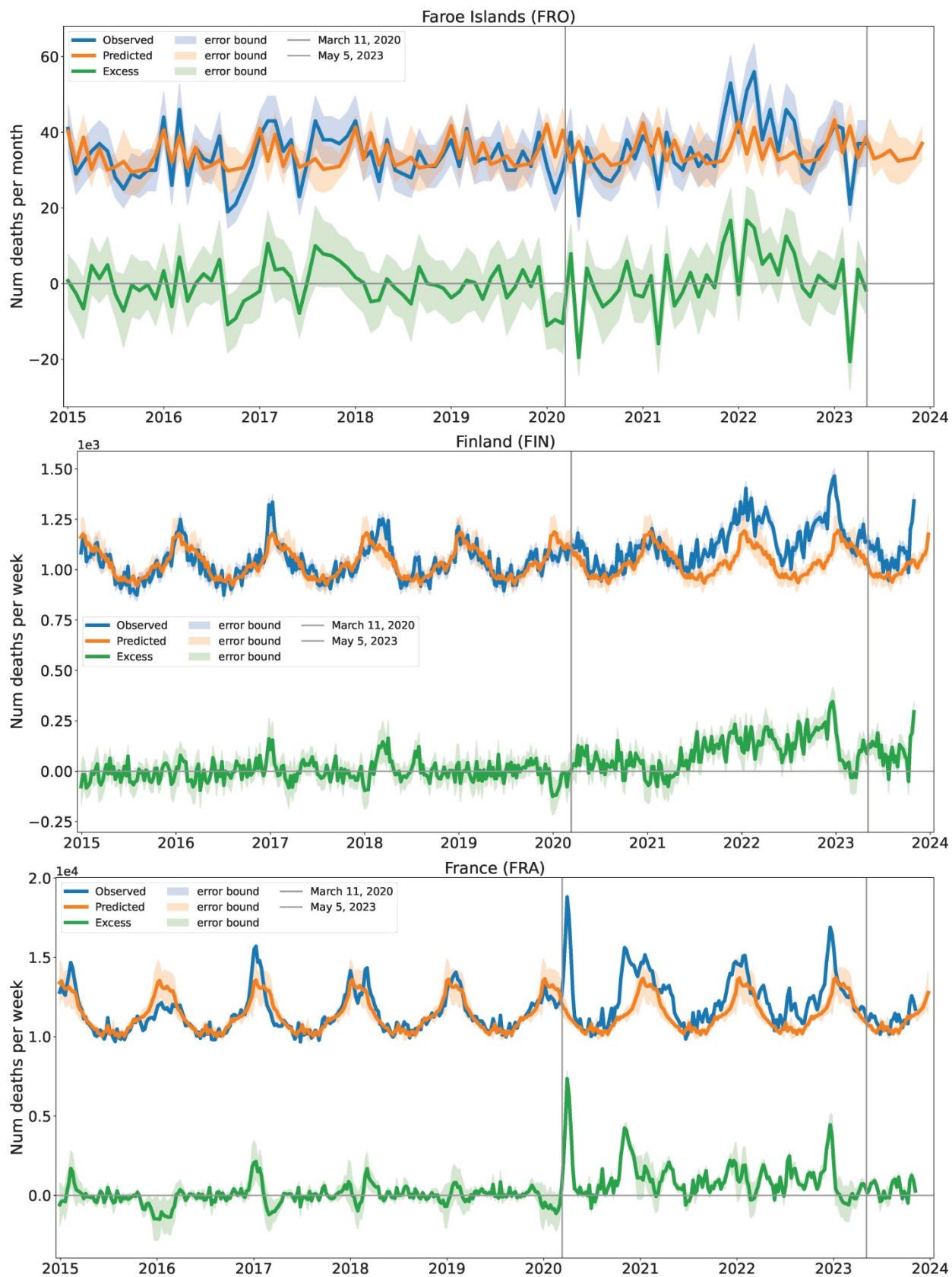




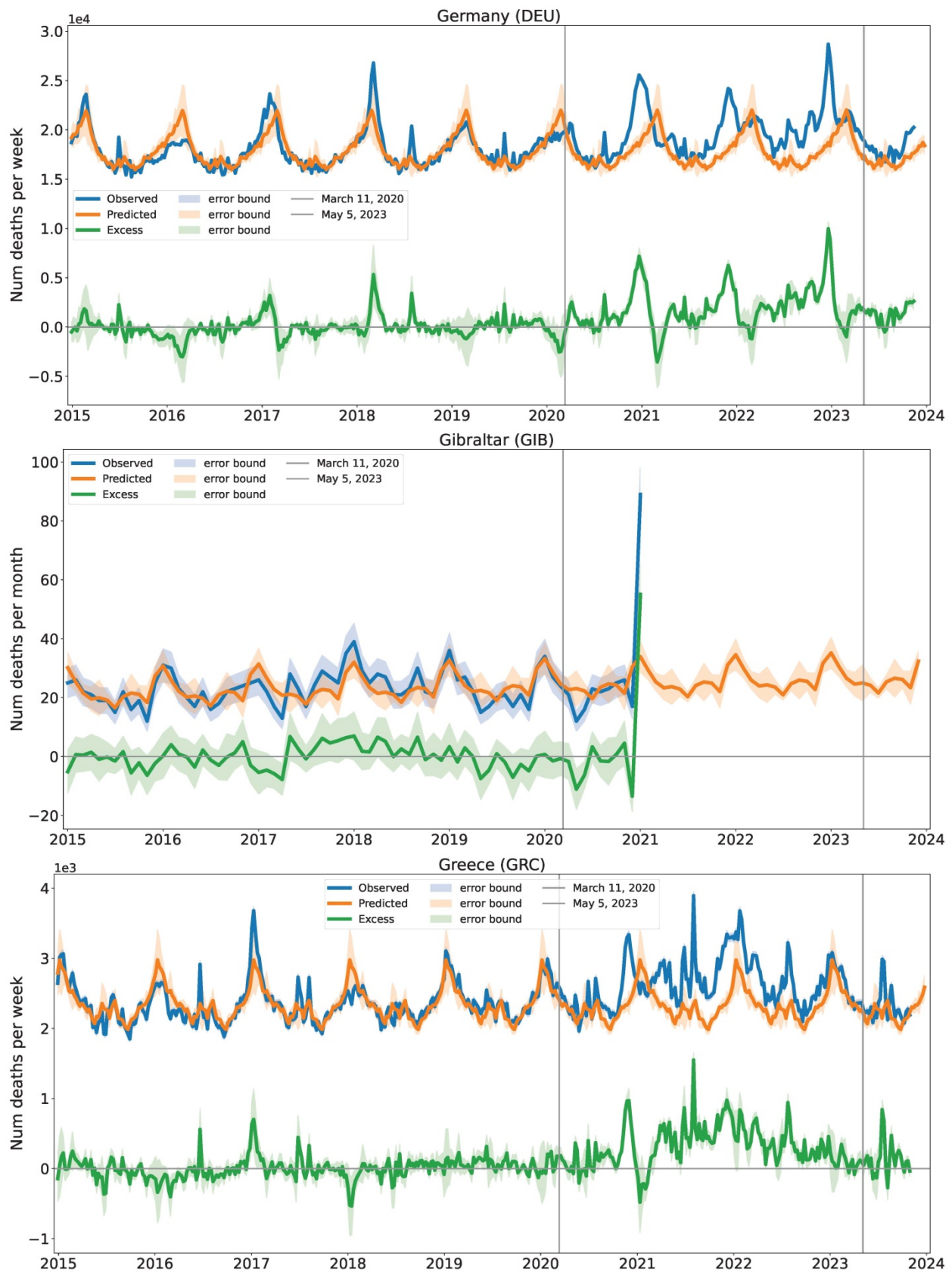


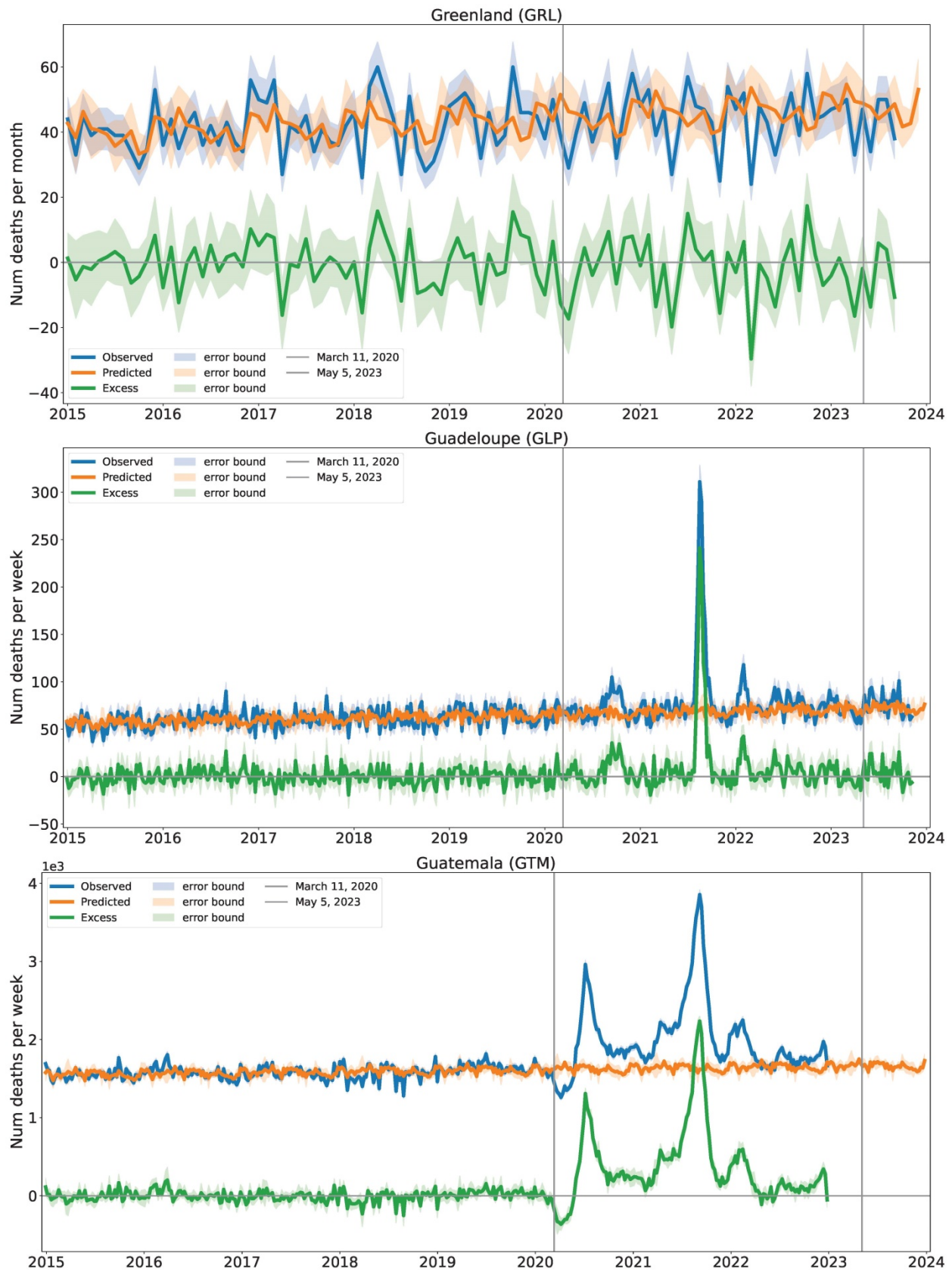




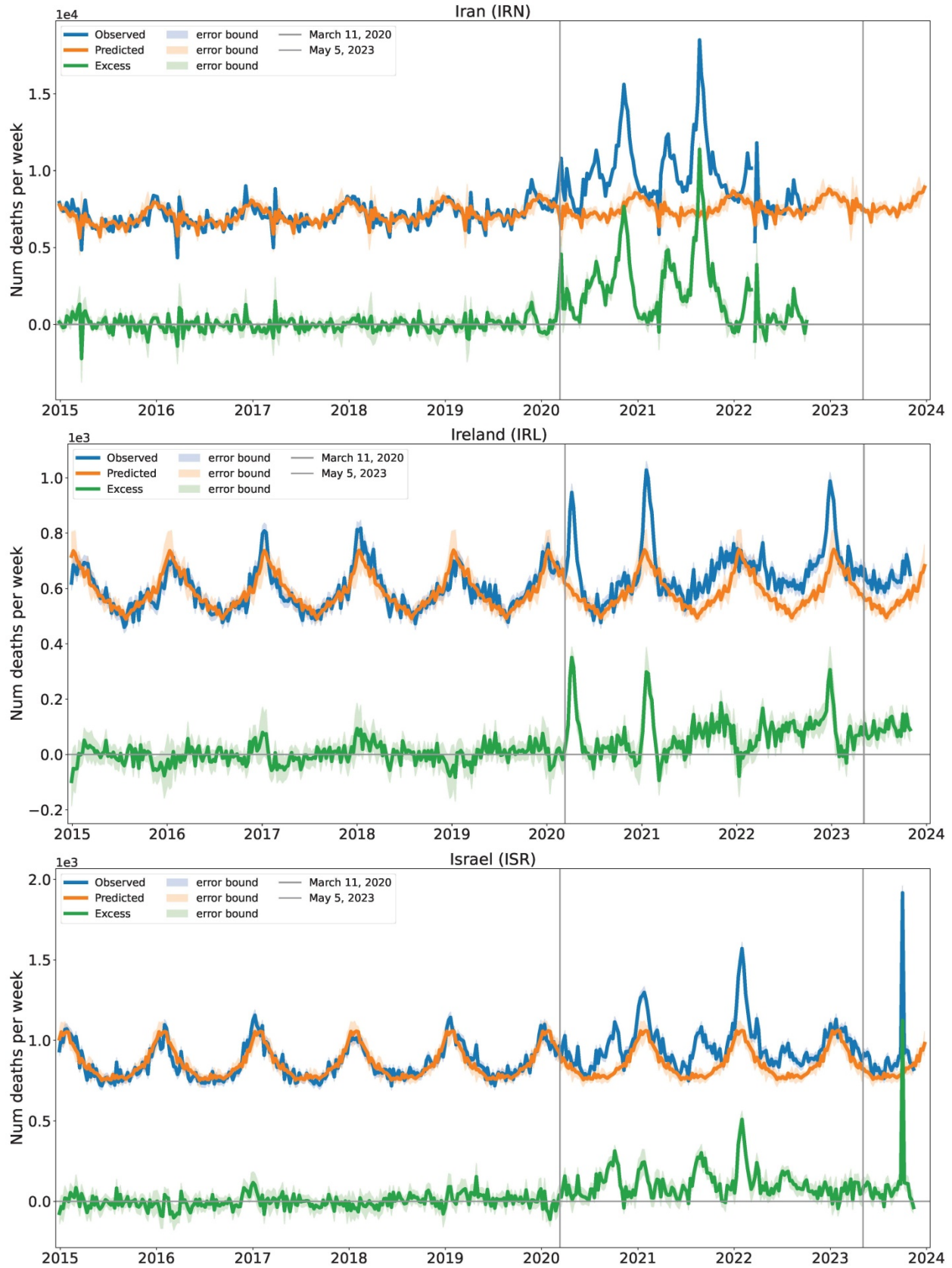


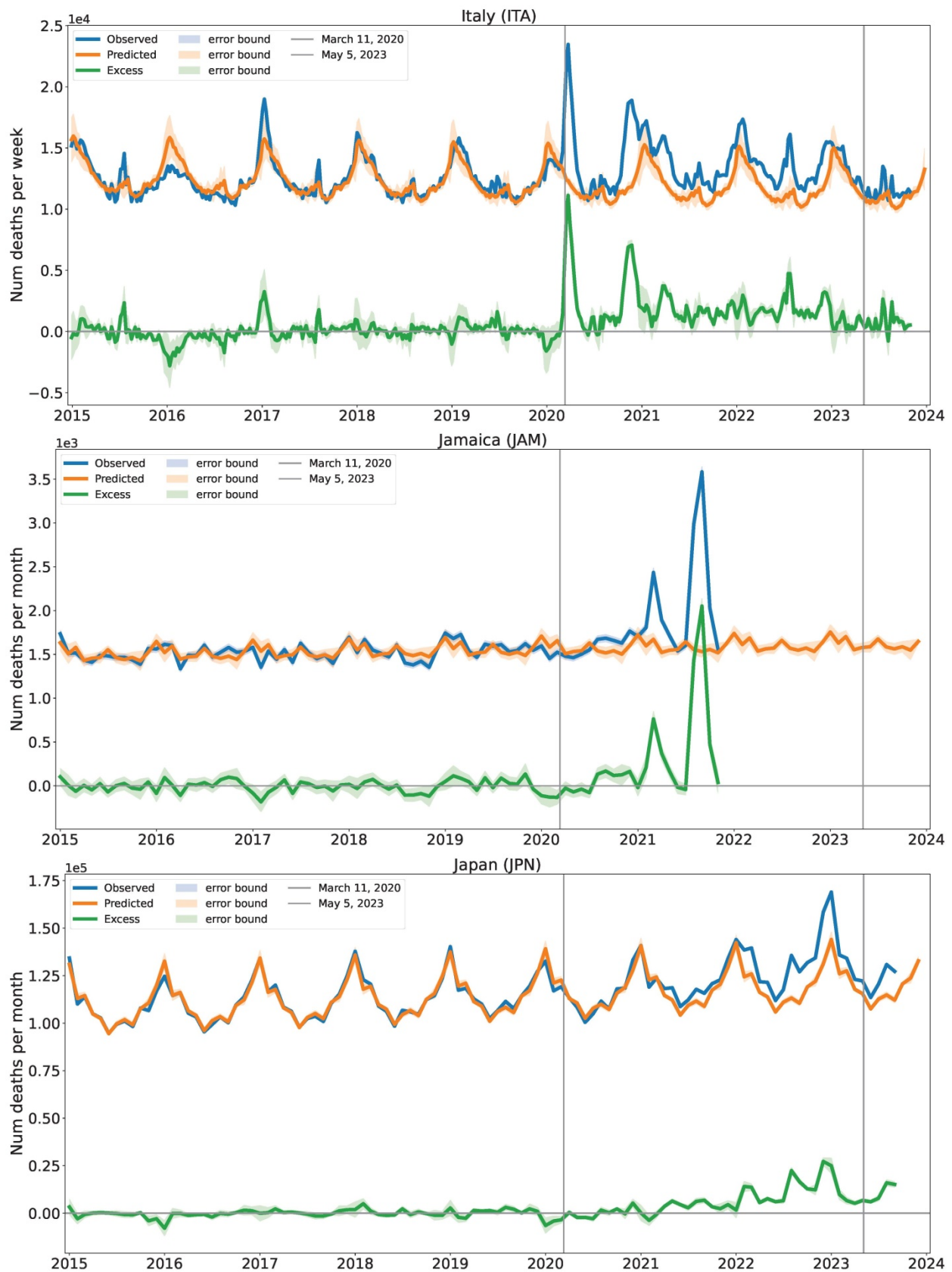


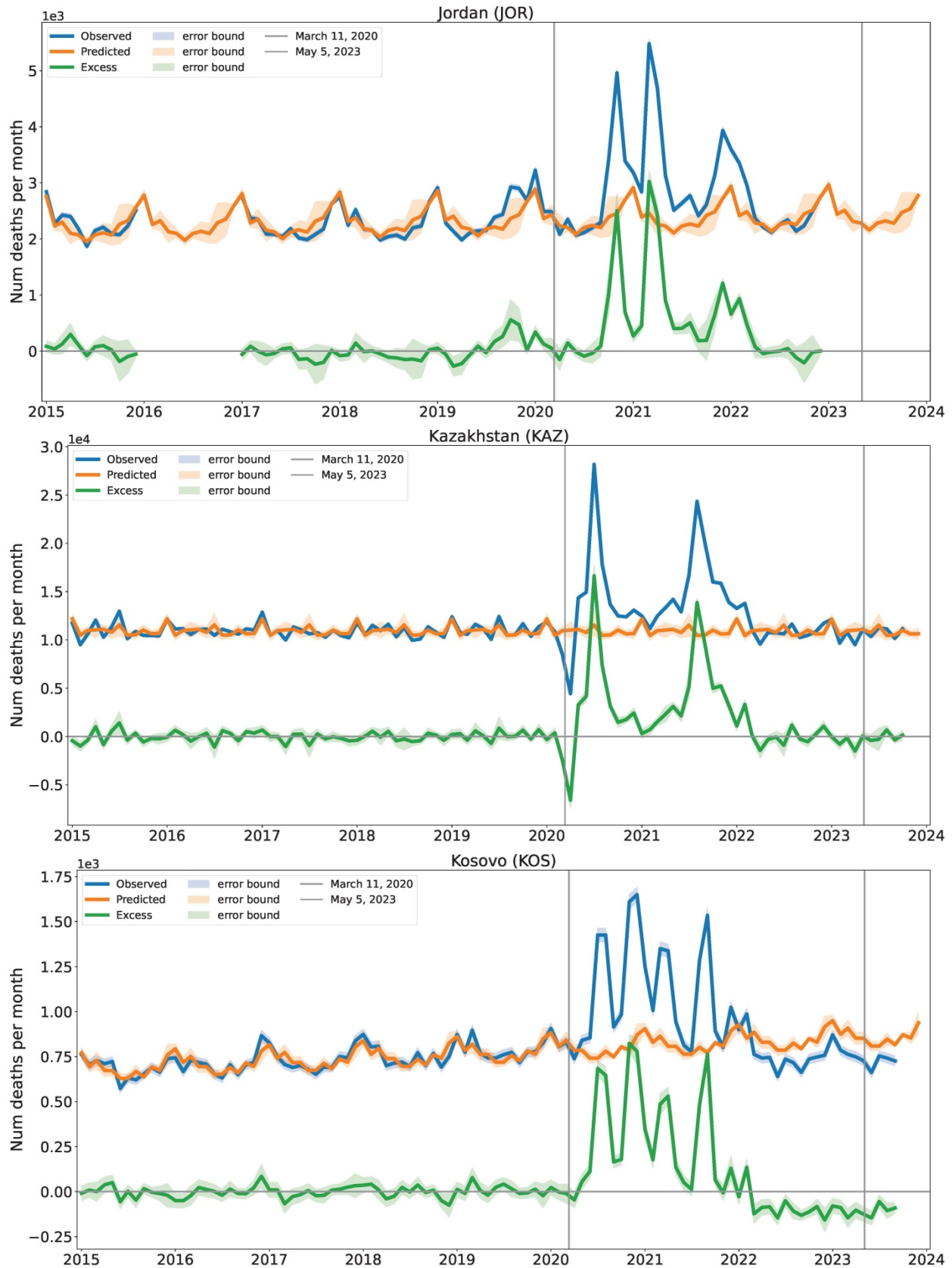


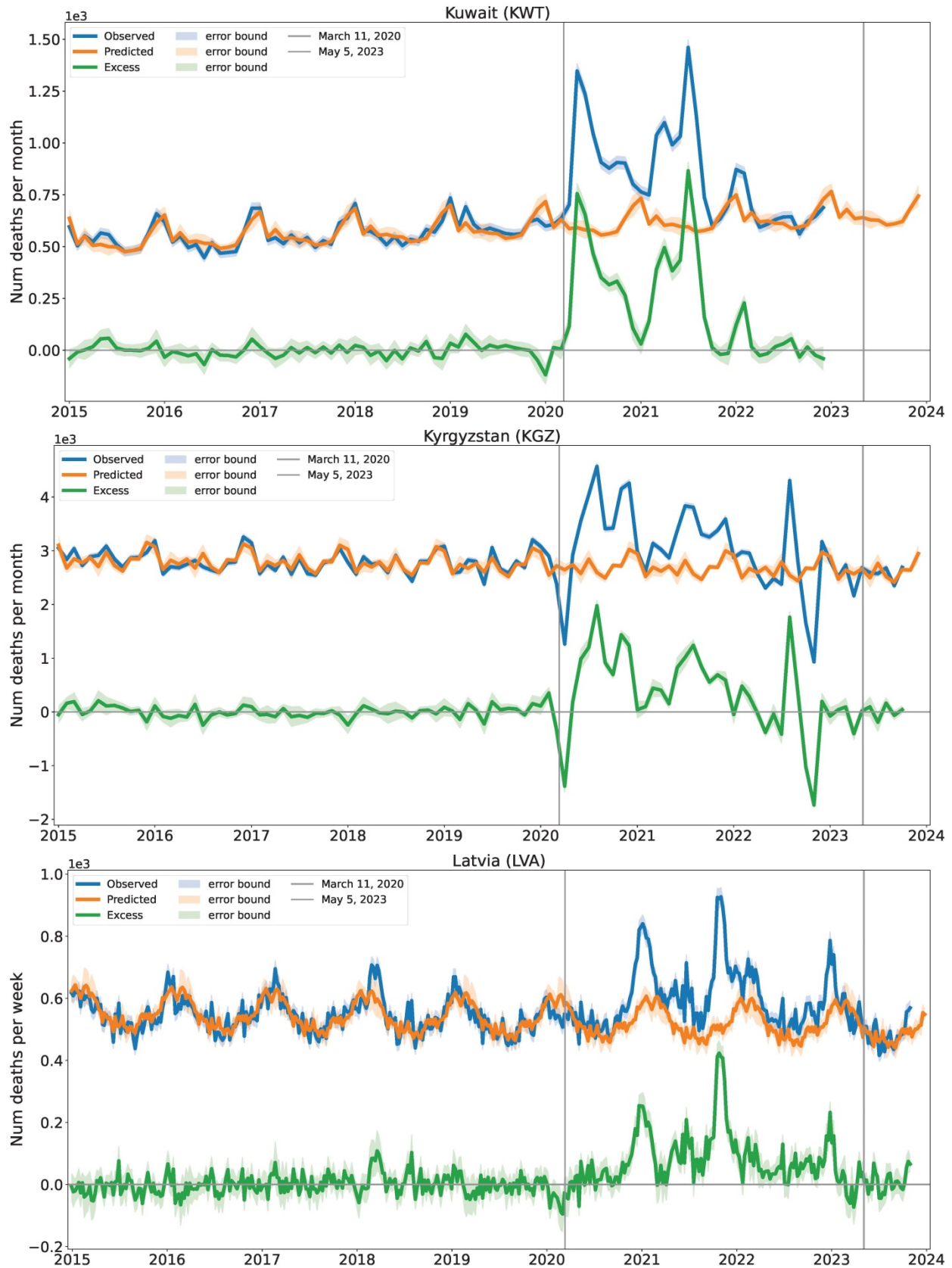


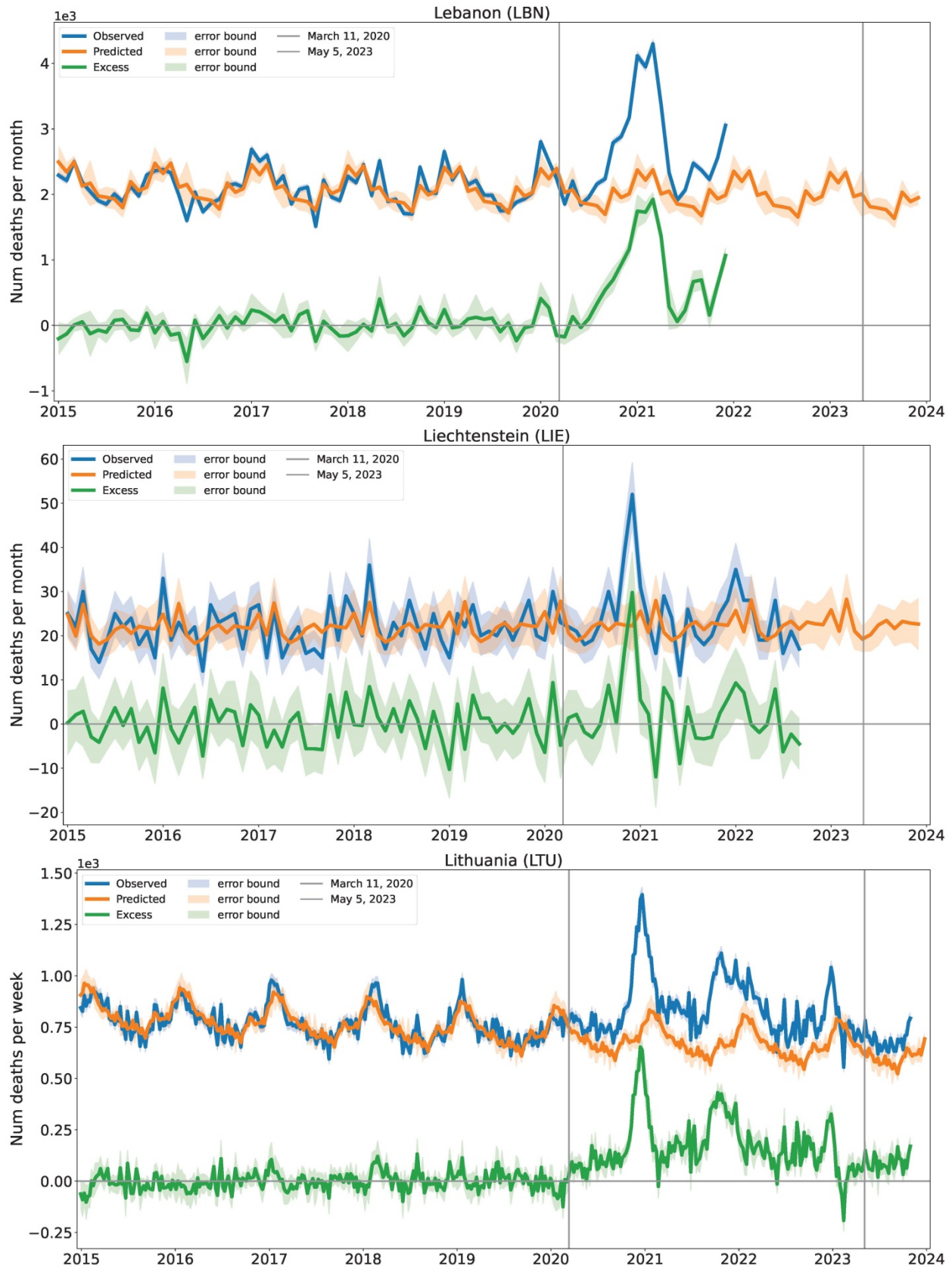


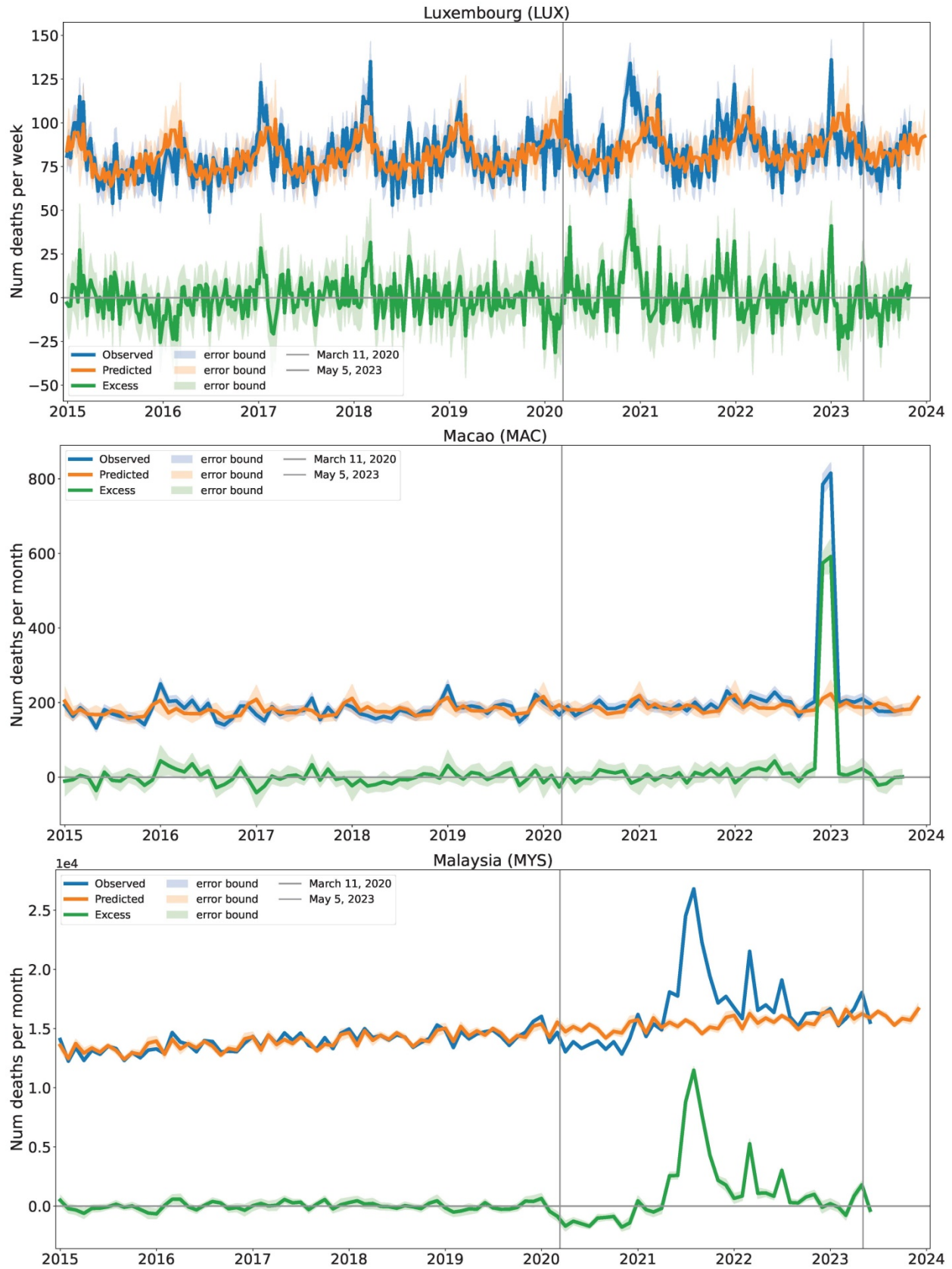


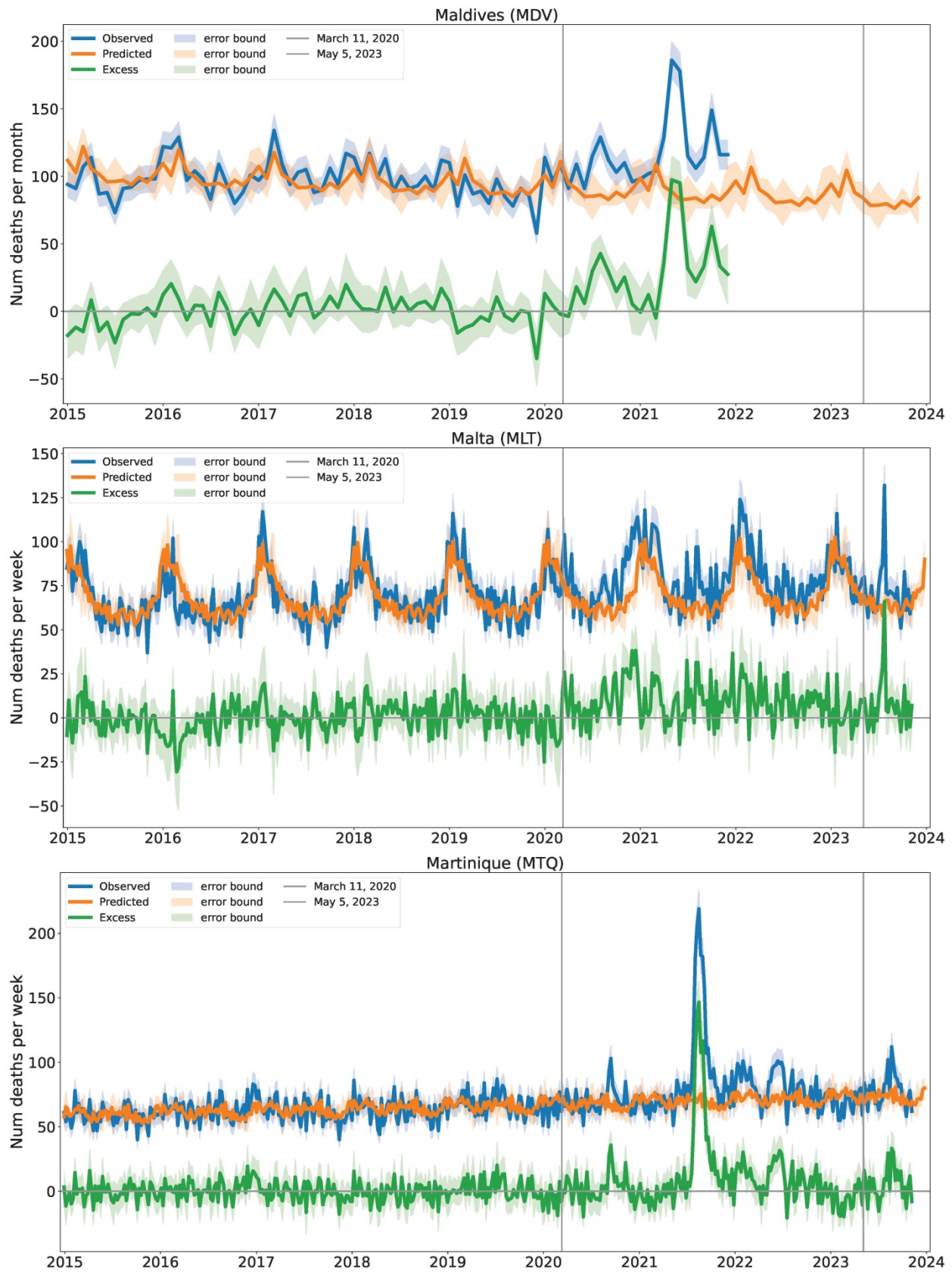


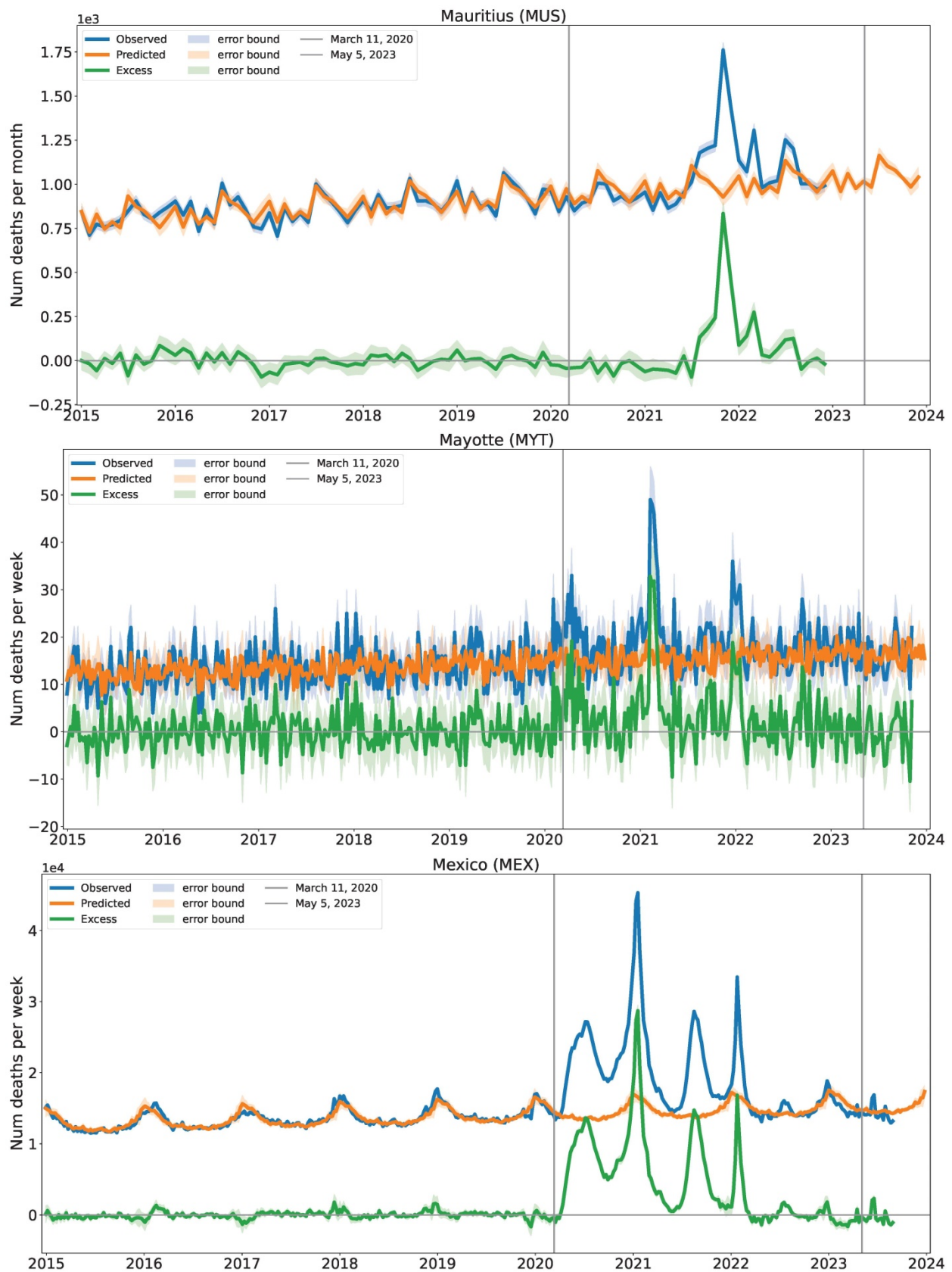


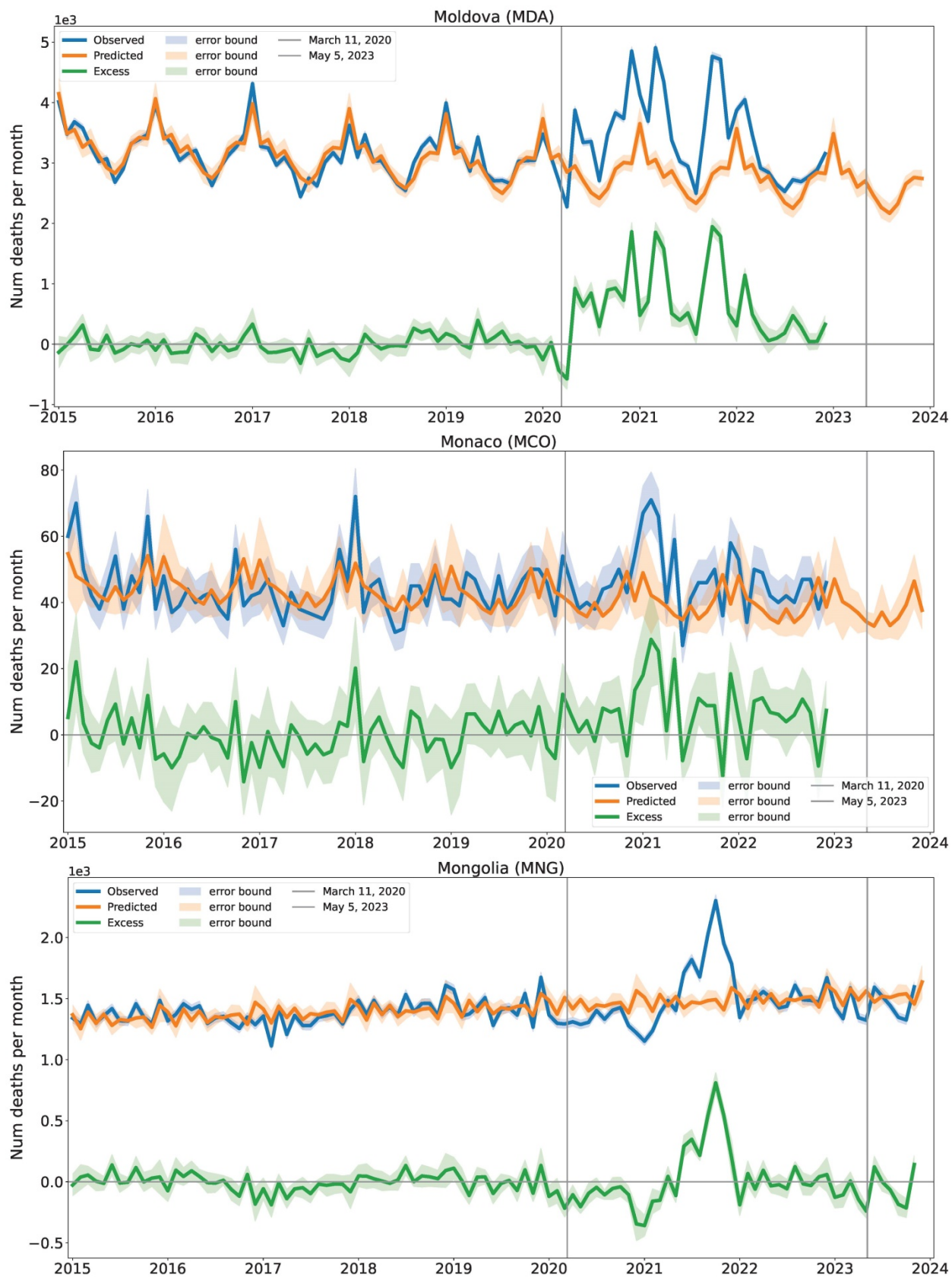


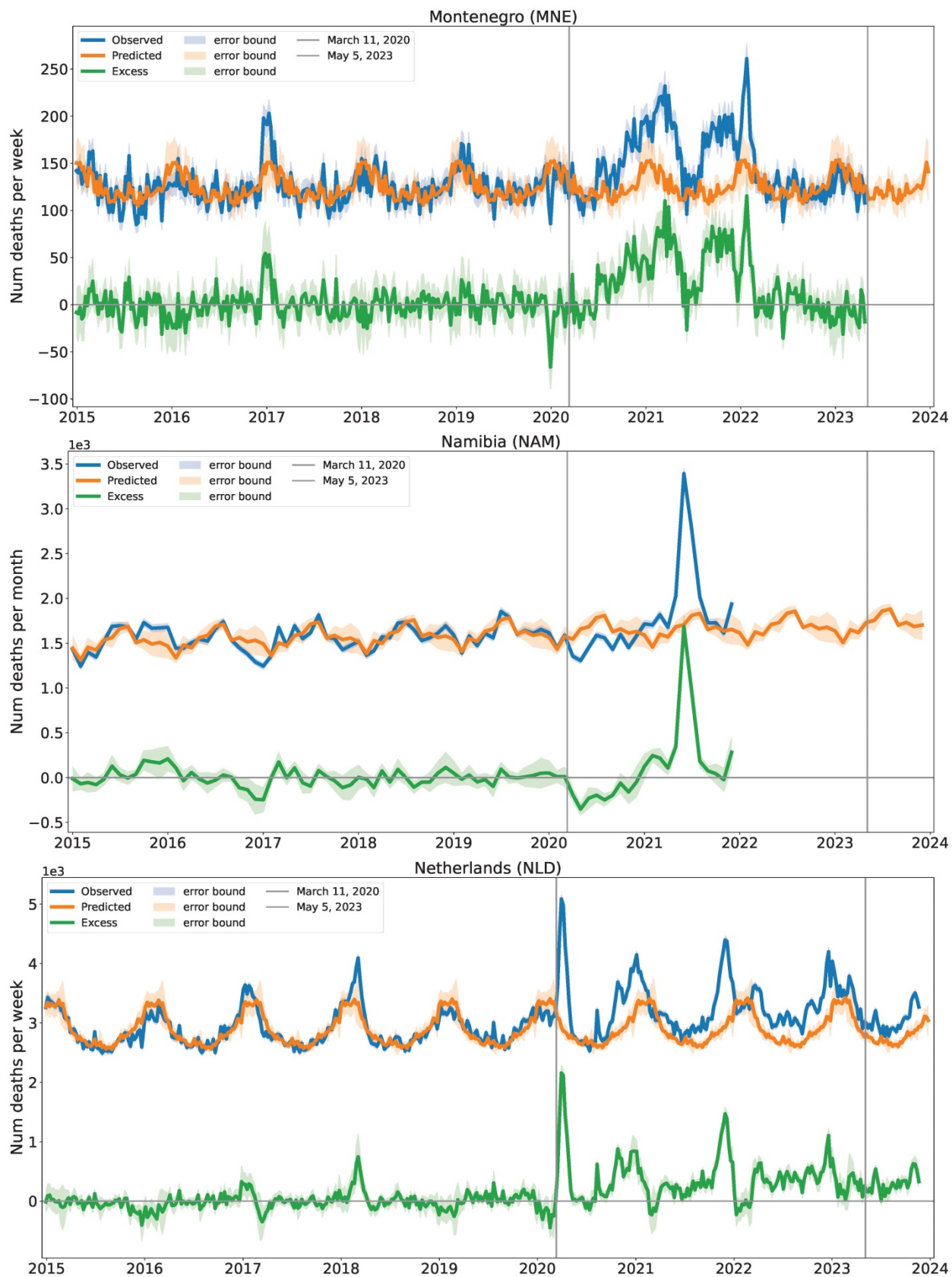


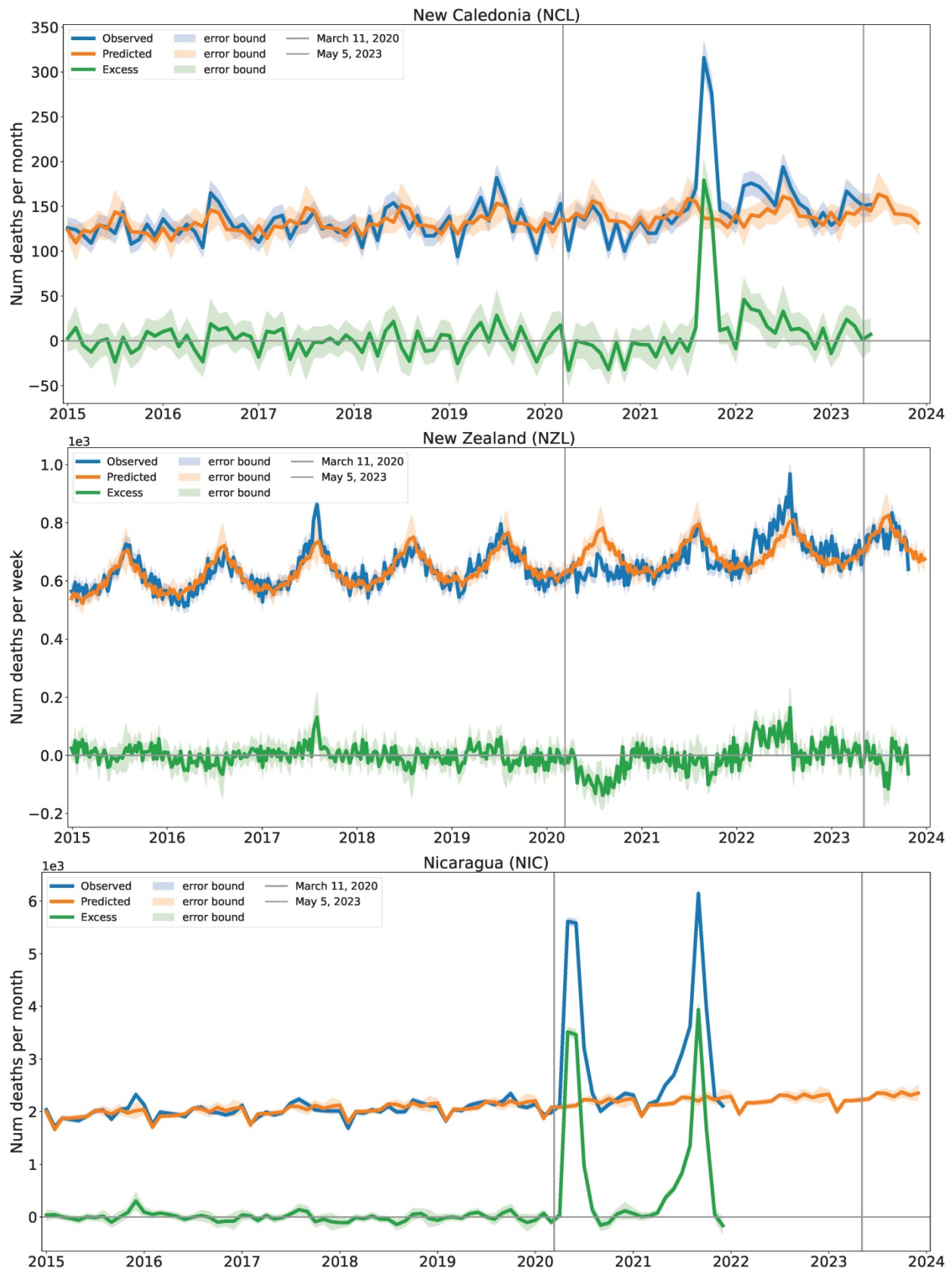




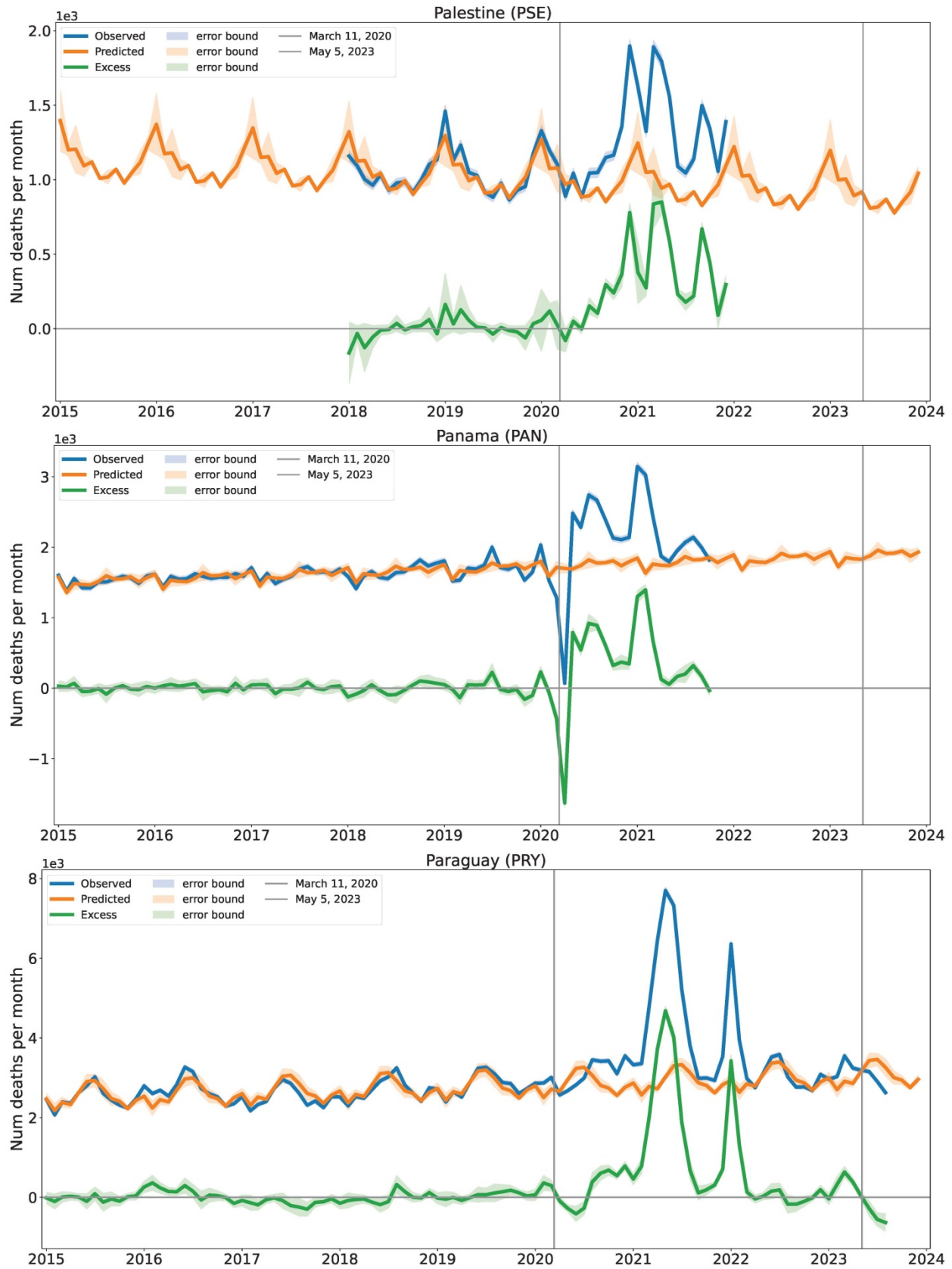


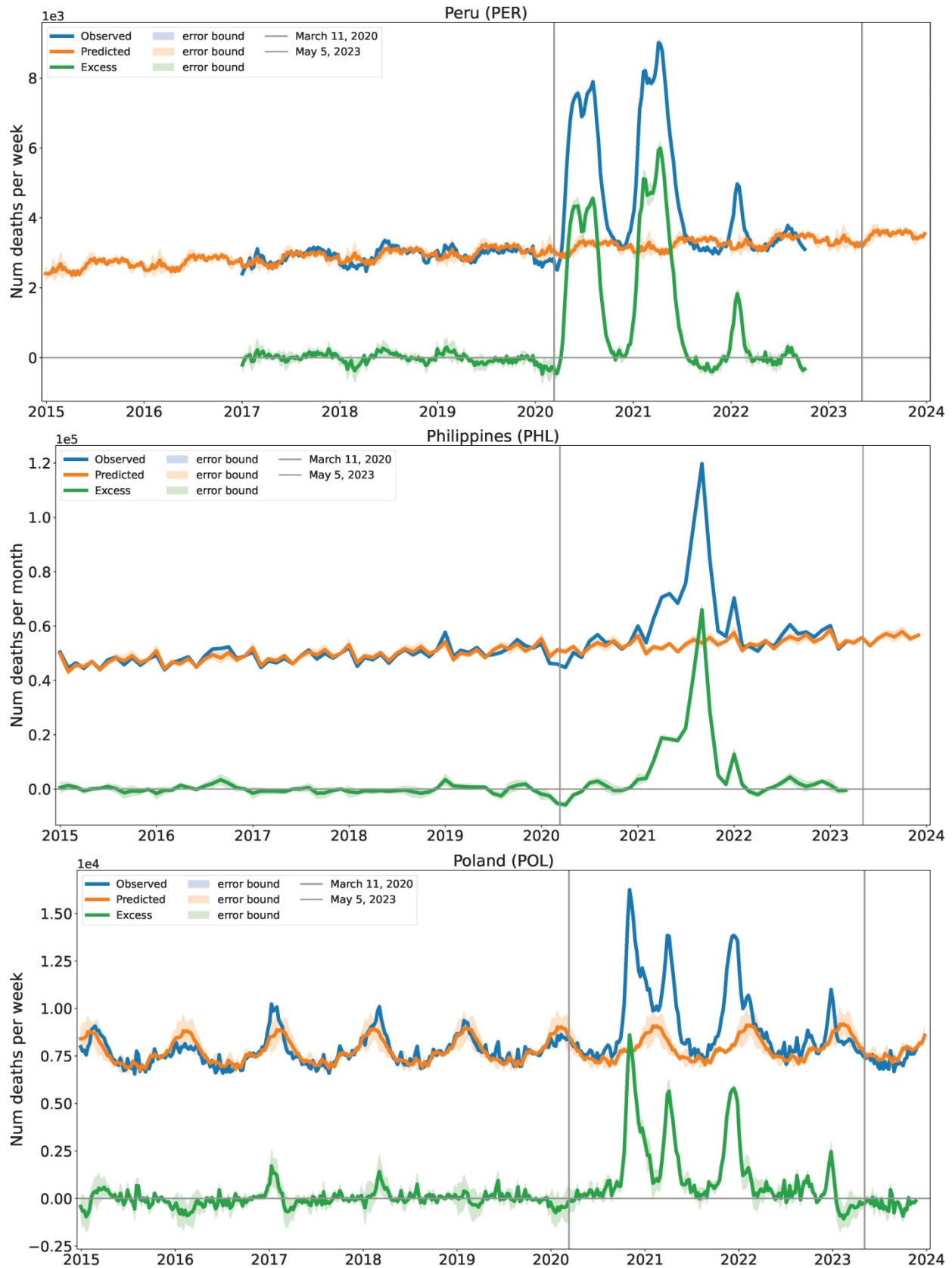


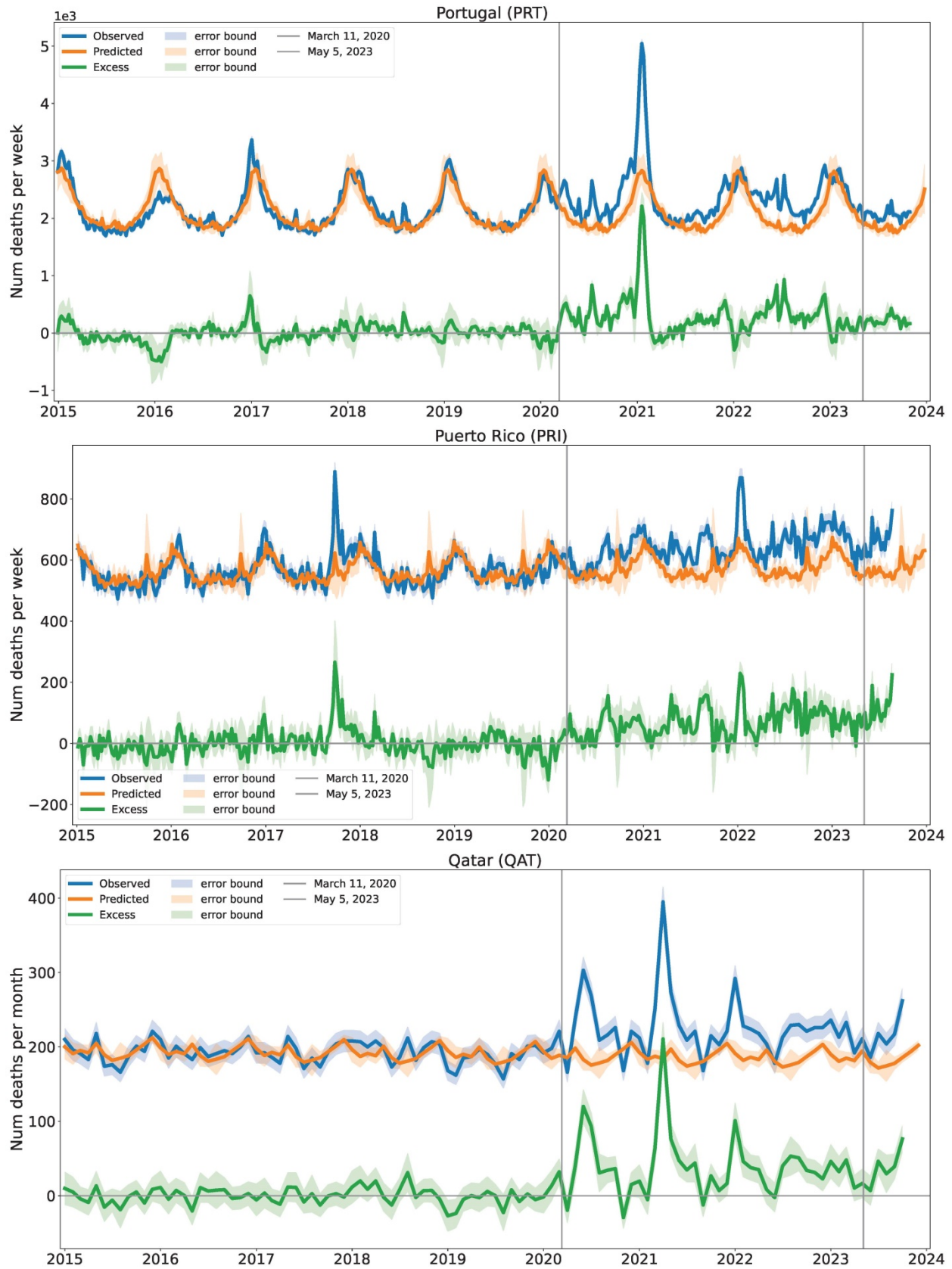


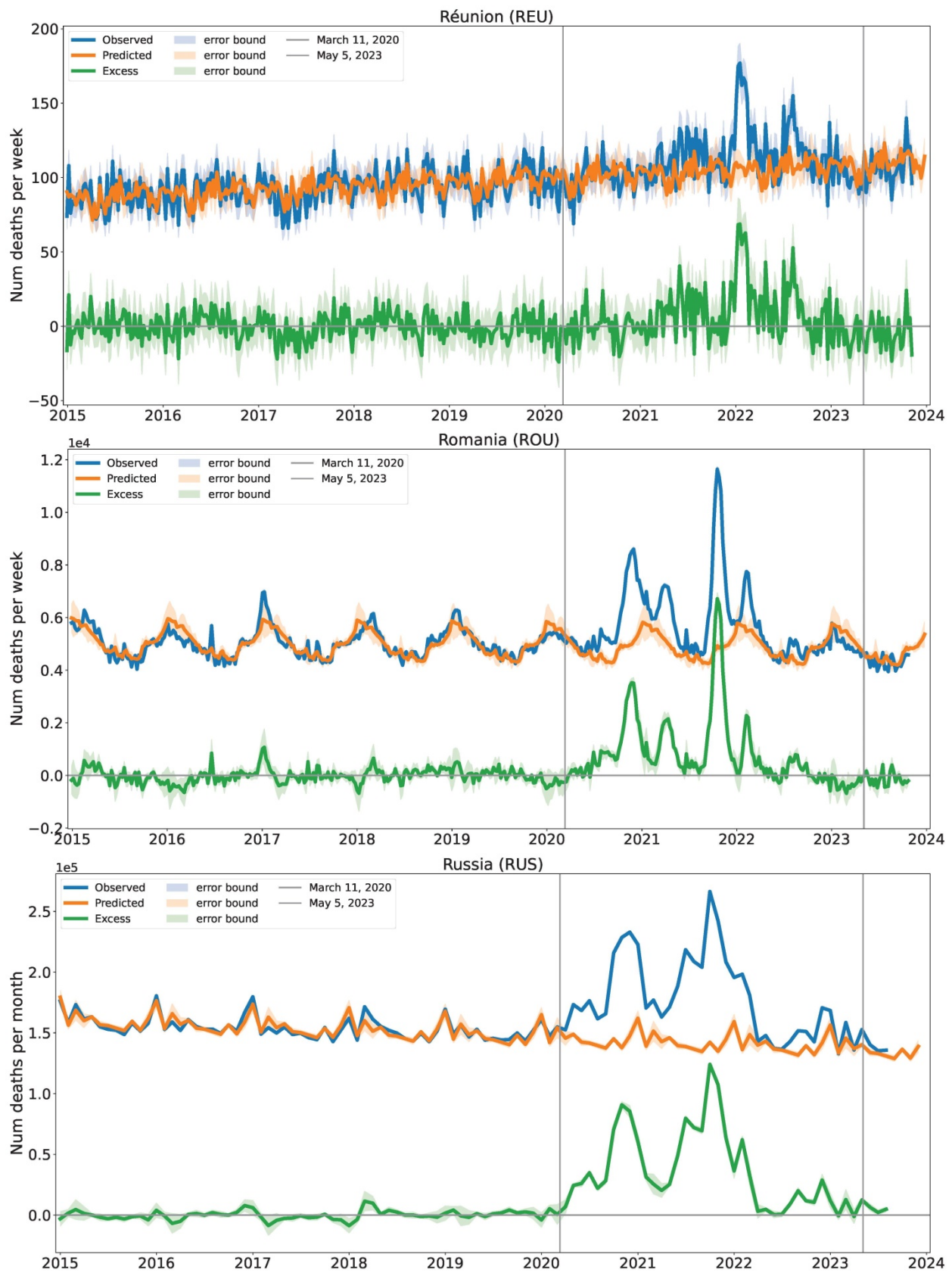


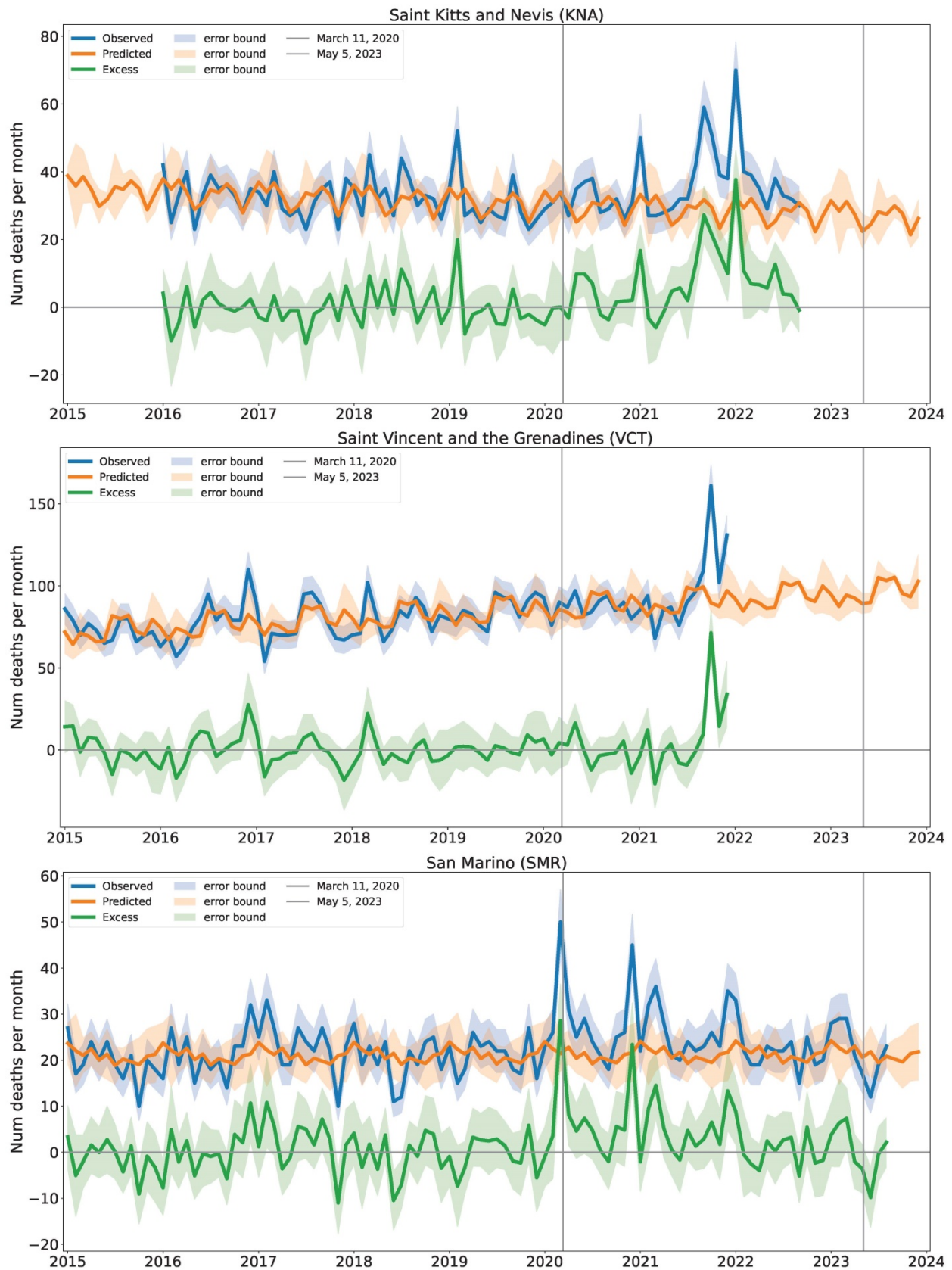


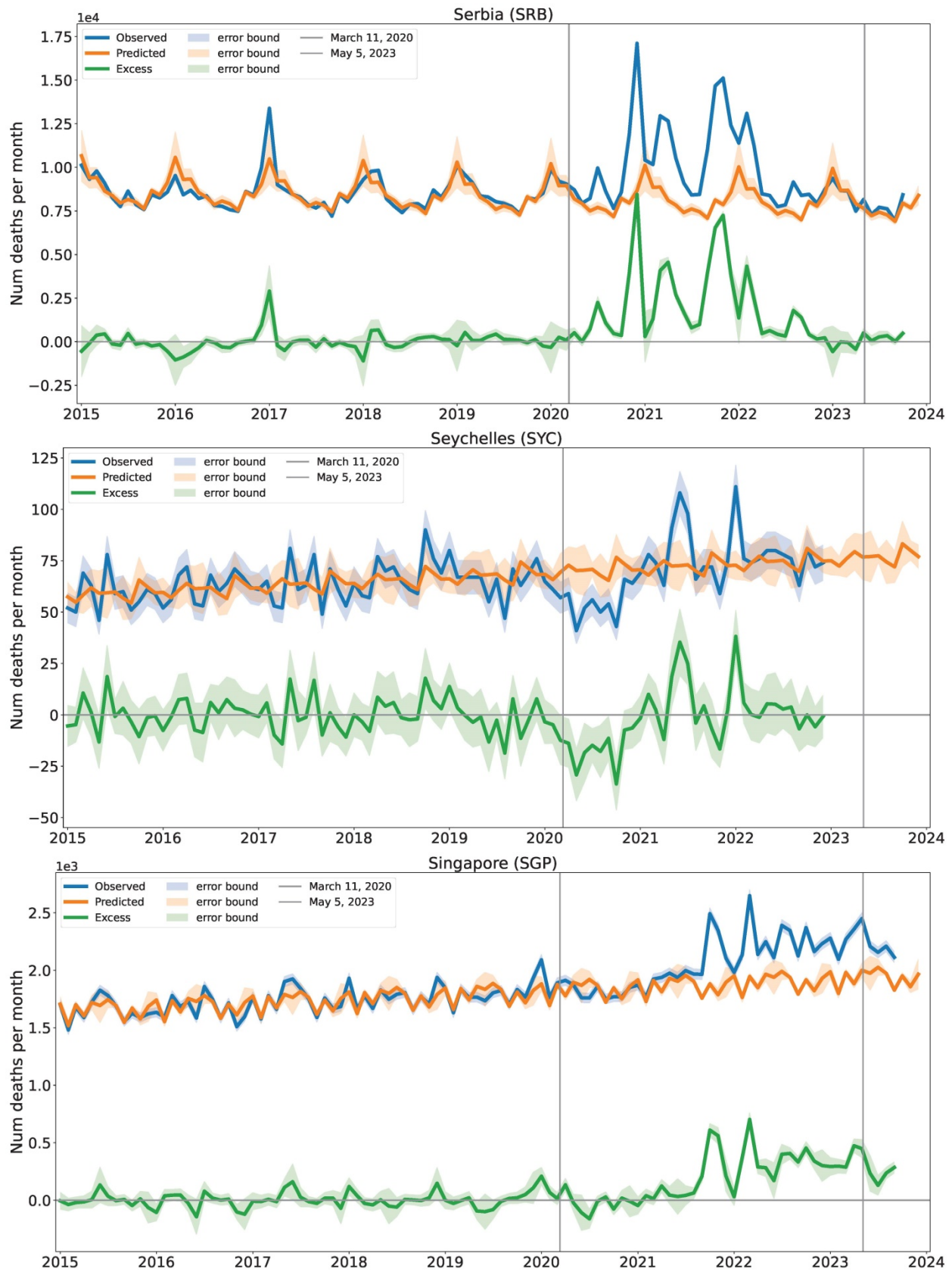


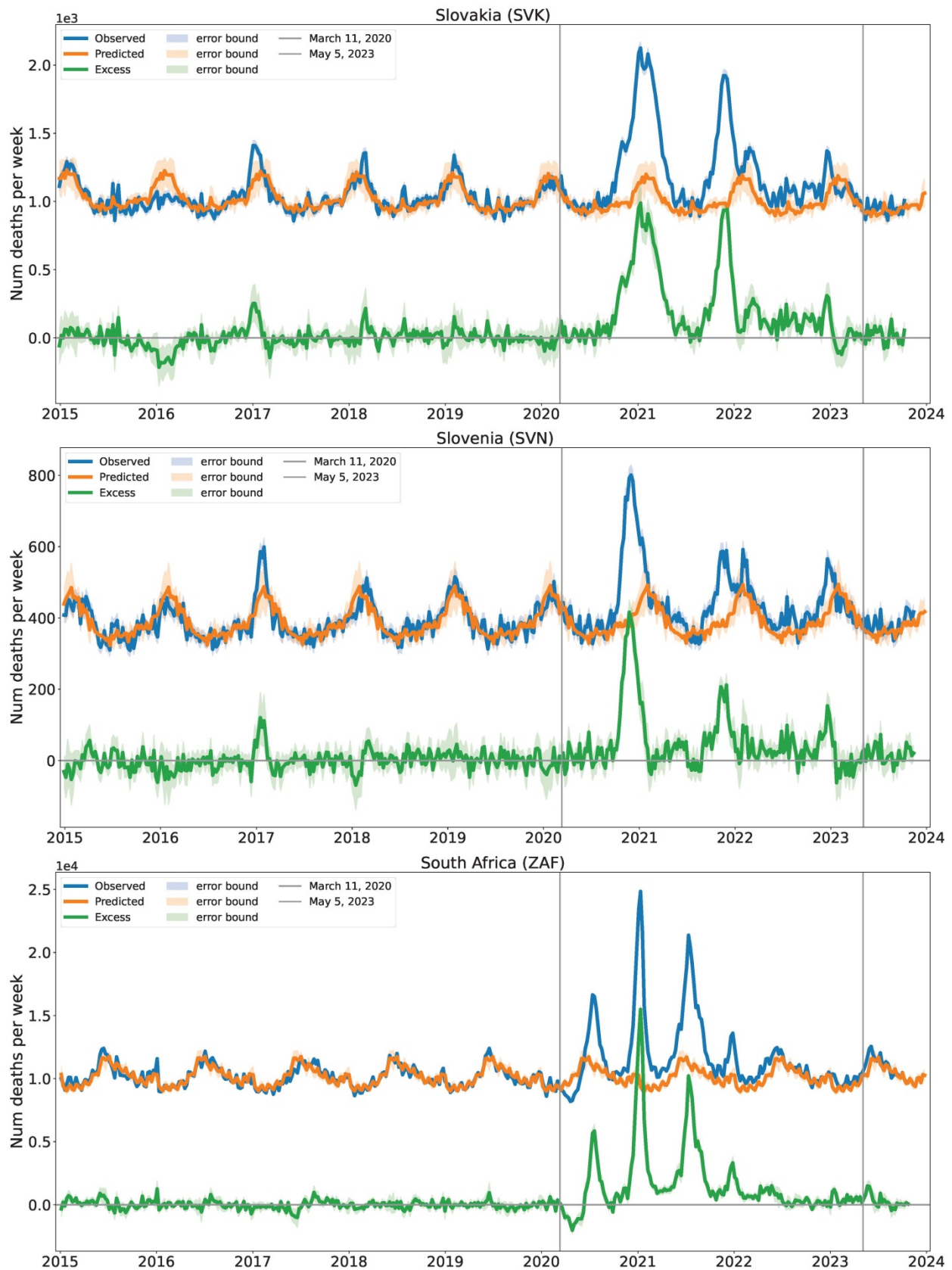


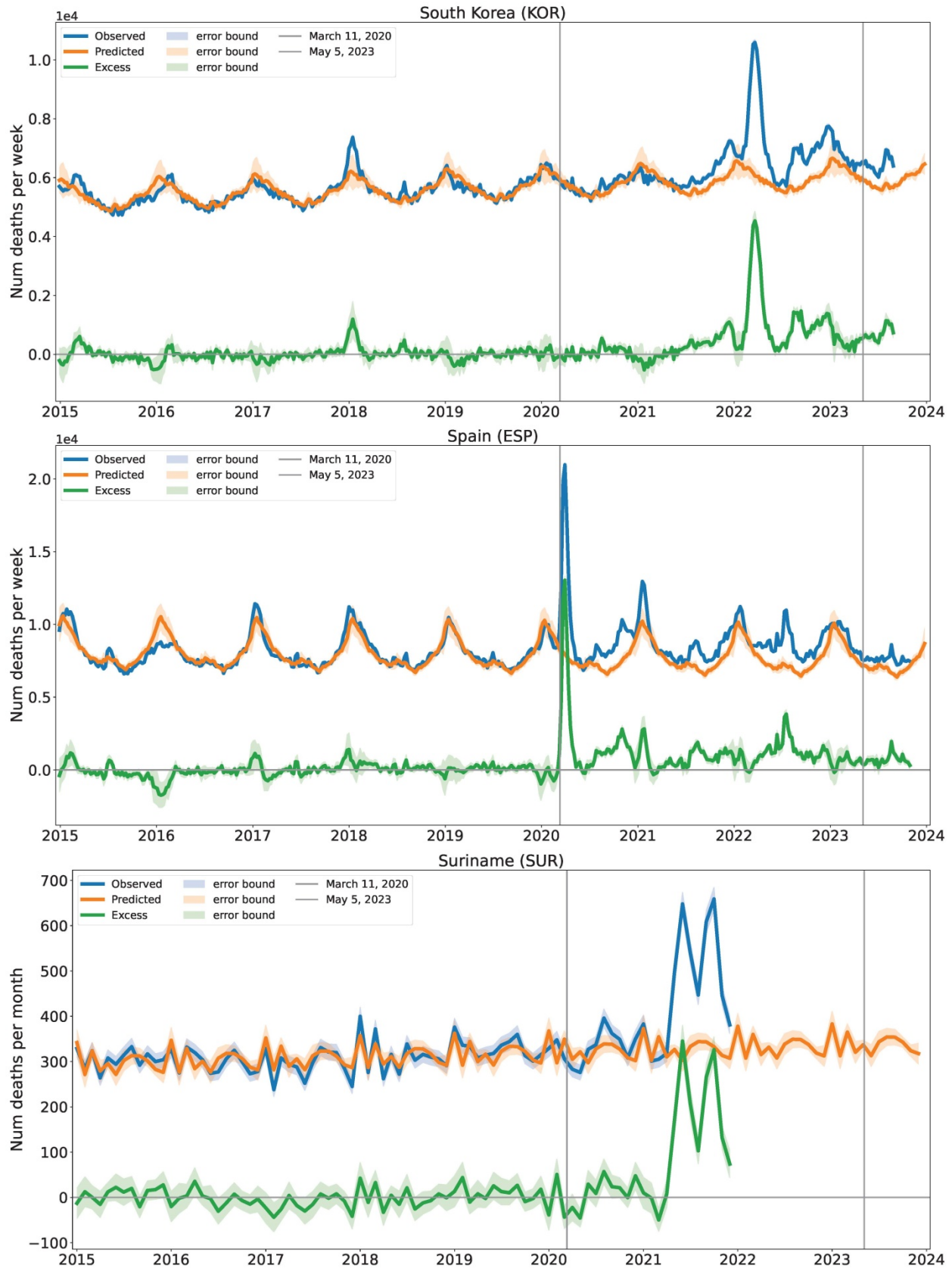




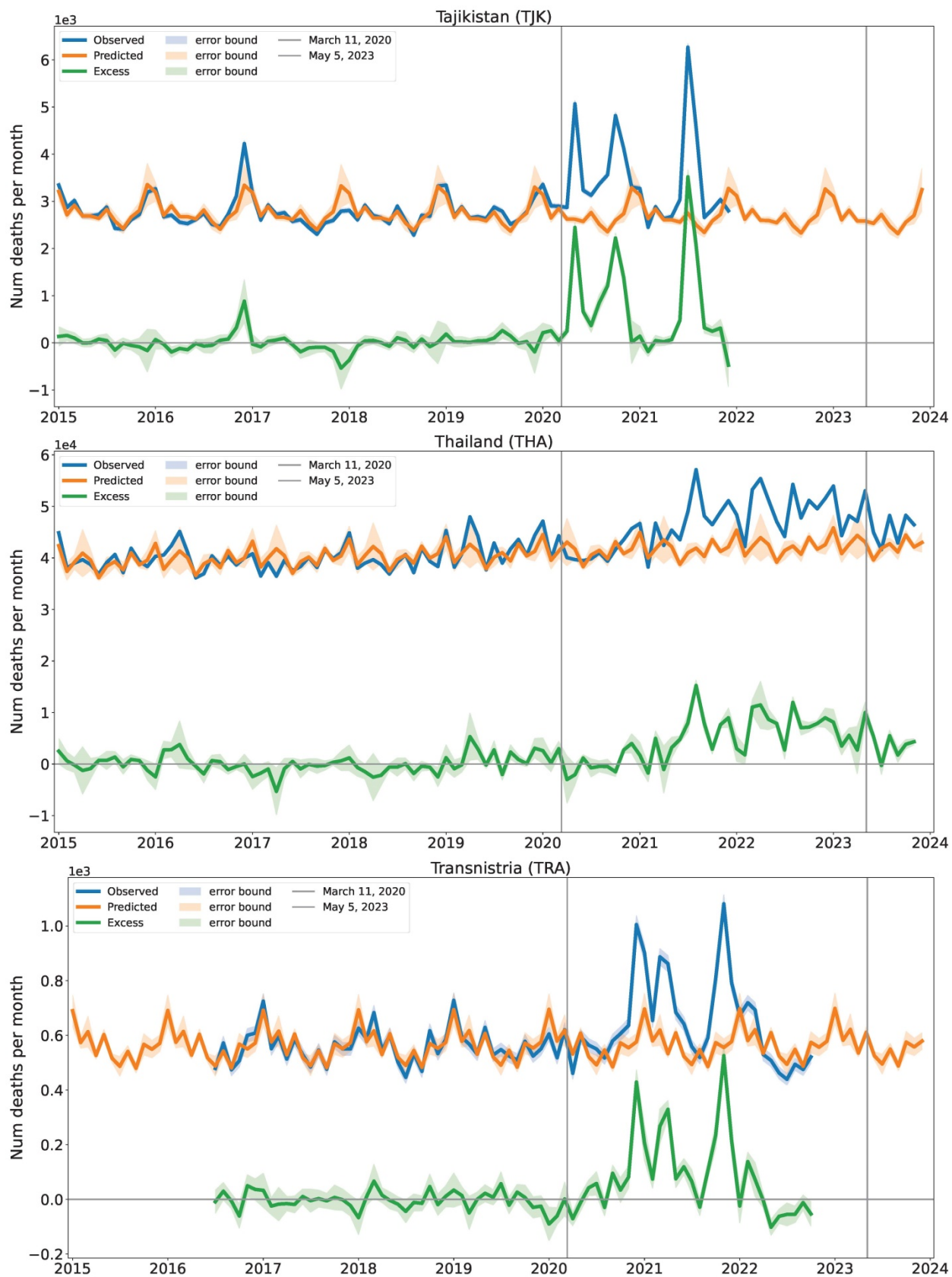


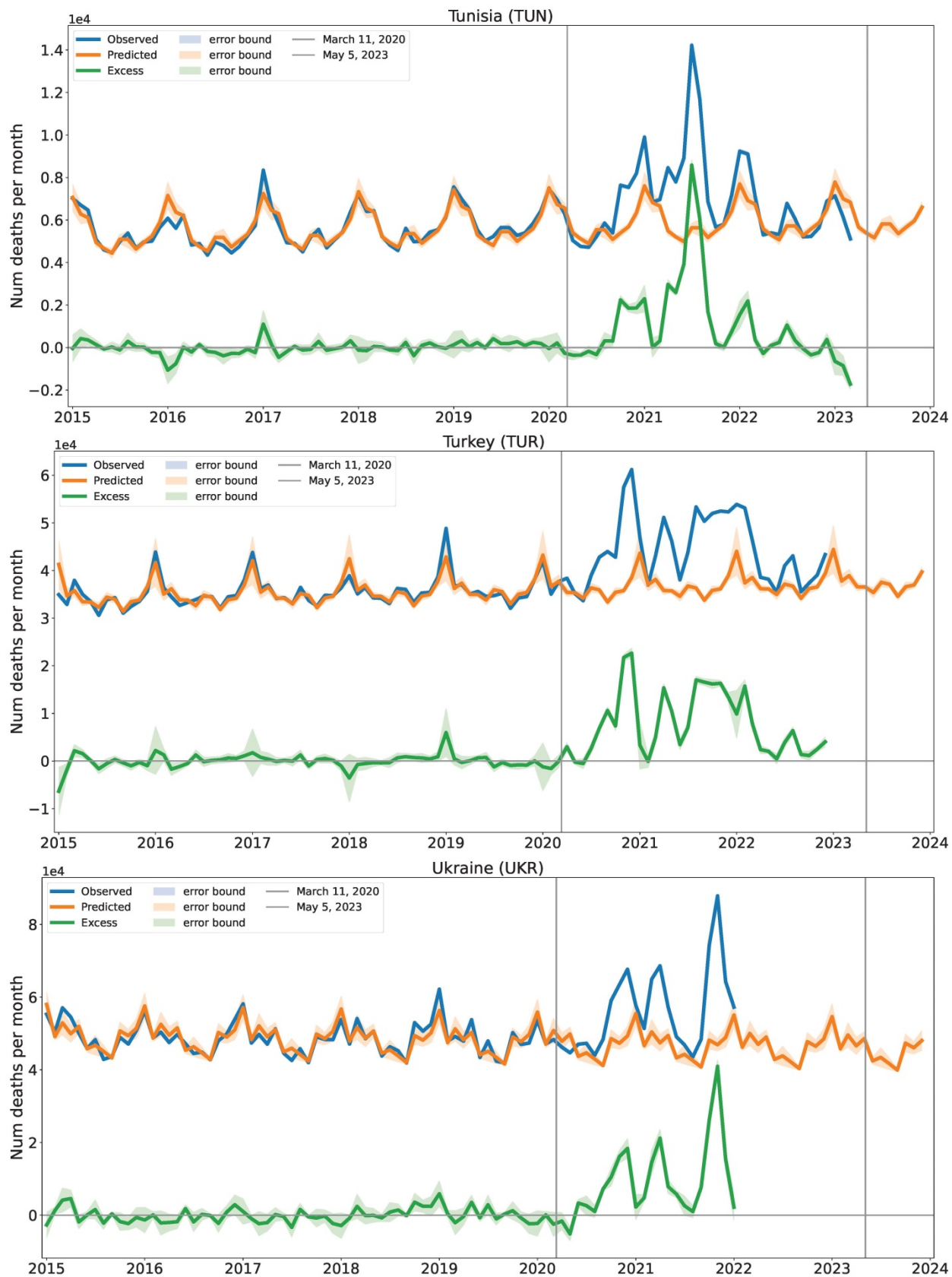


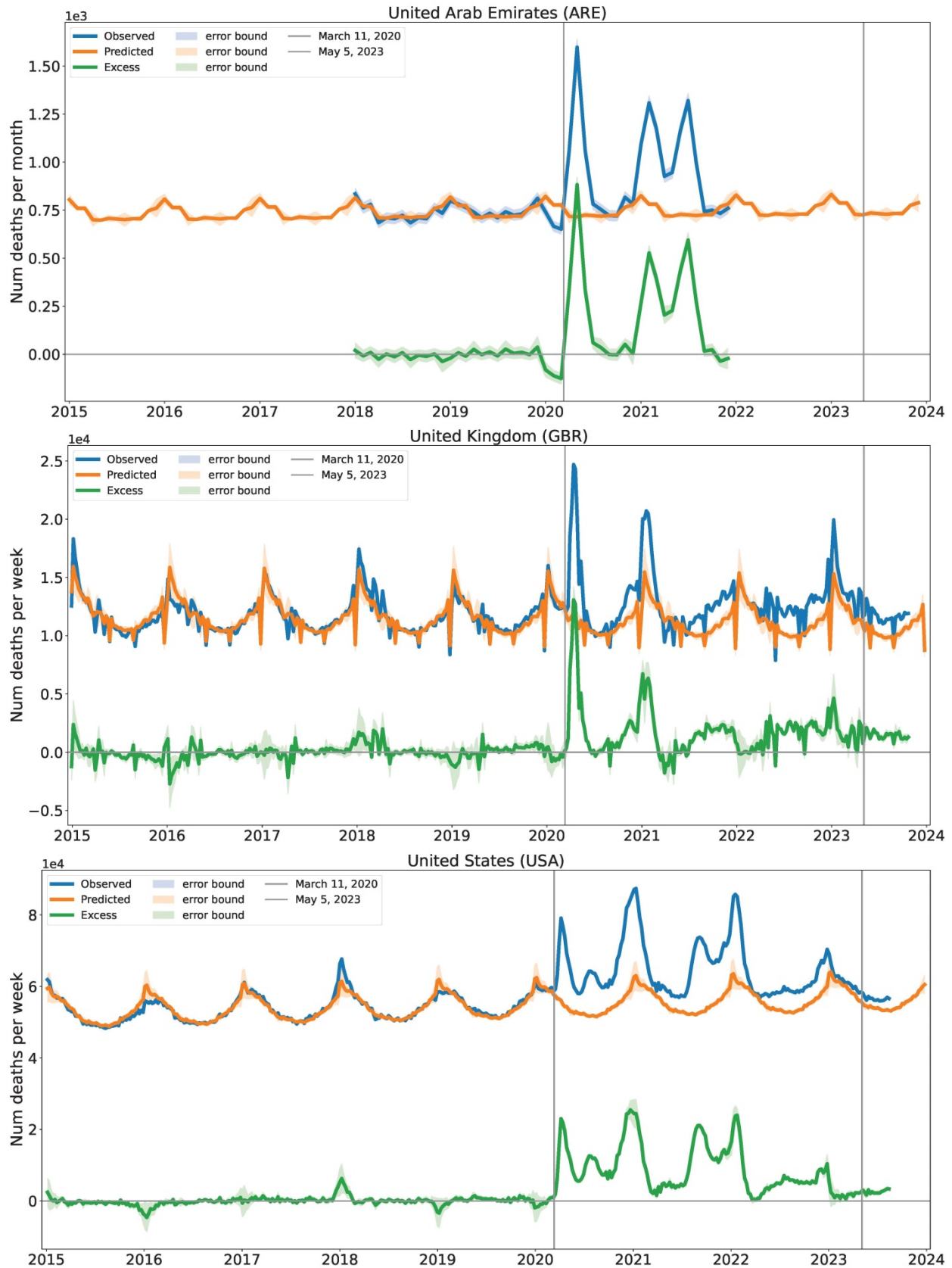


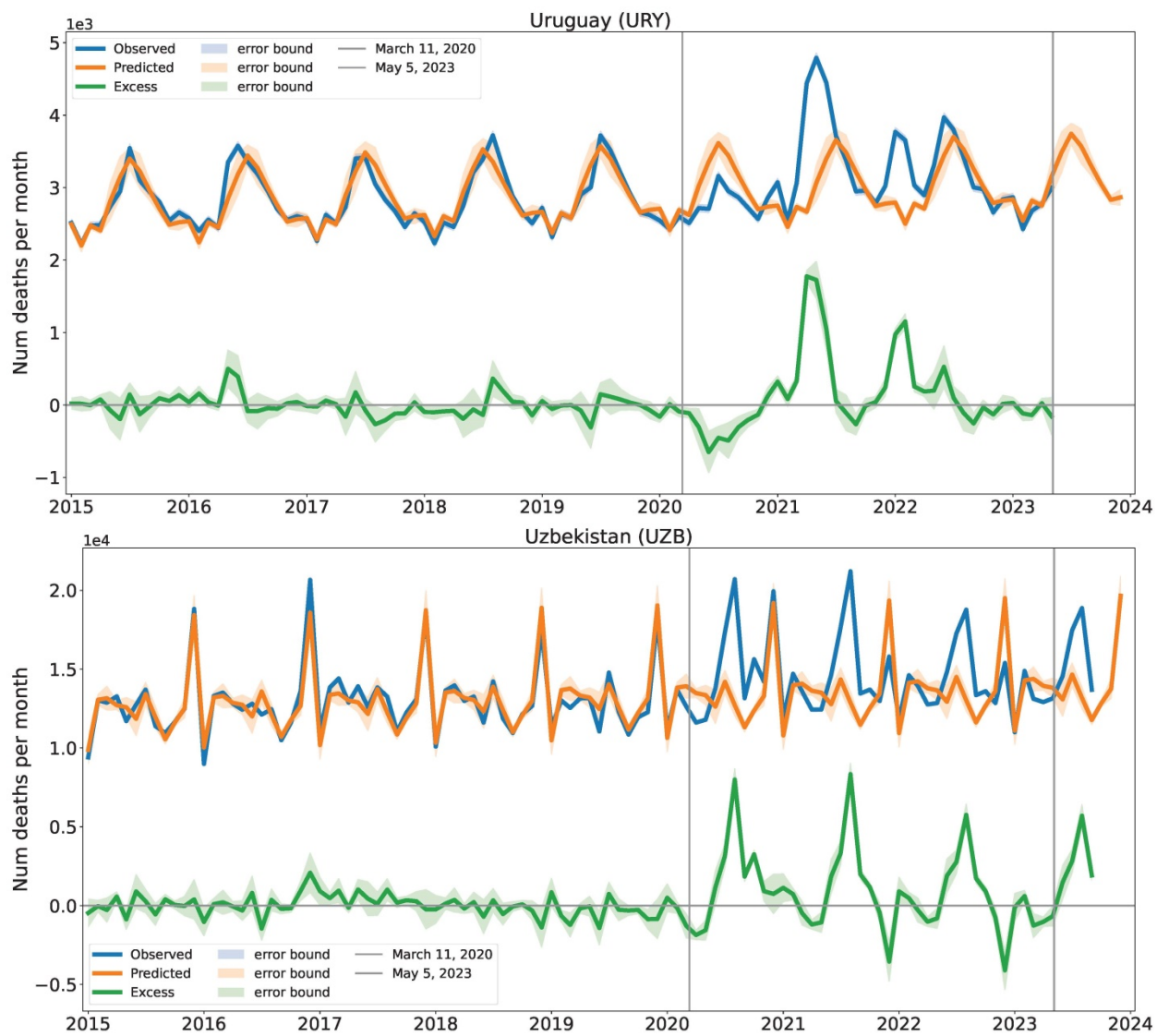












End of Appendix A

Appendix B: All-cause mortality, excess all-cause mortality, and cumulative, in 125 countries, and vaccine rollouts, 2018-2023

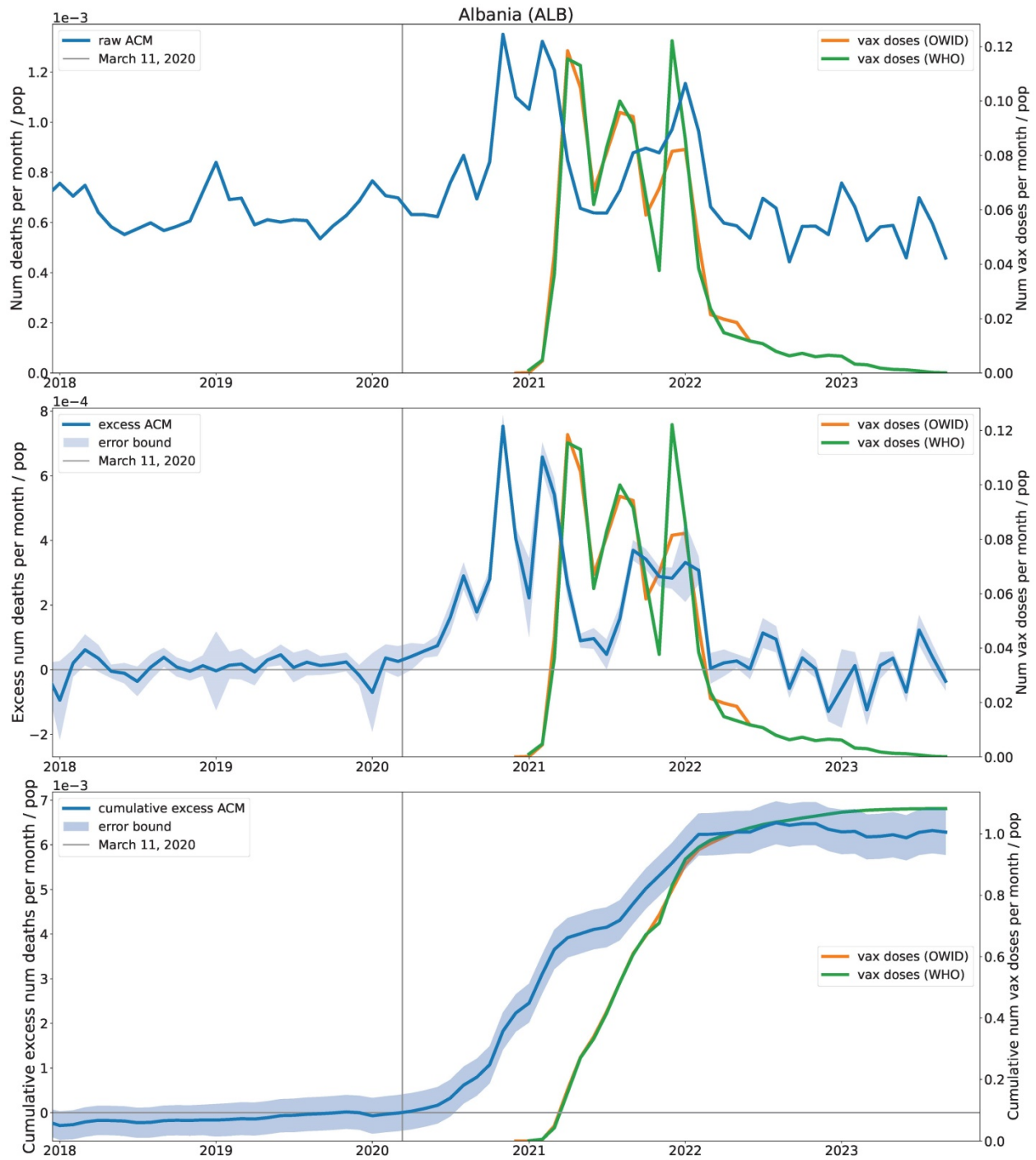
The figure in this Appendix has 125 consecutive three-part panels, in alphabetical order of country name. Each panel, for a given country, has three subpanels, as follows.

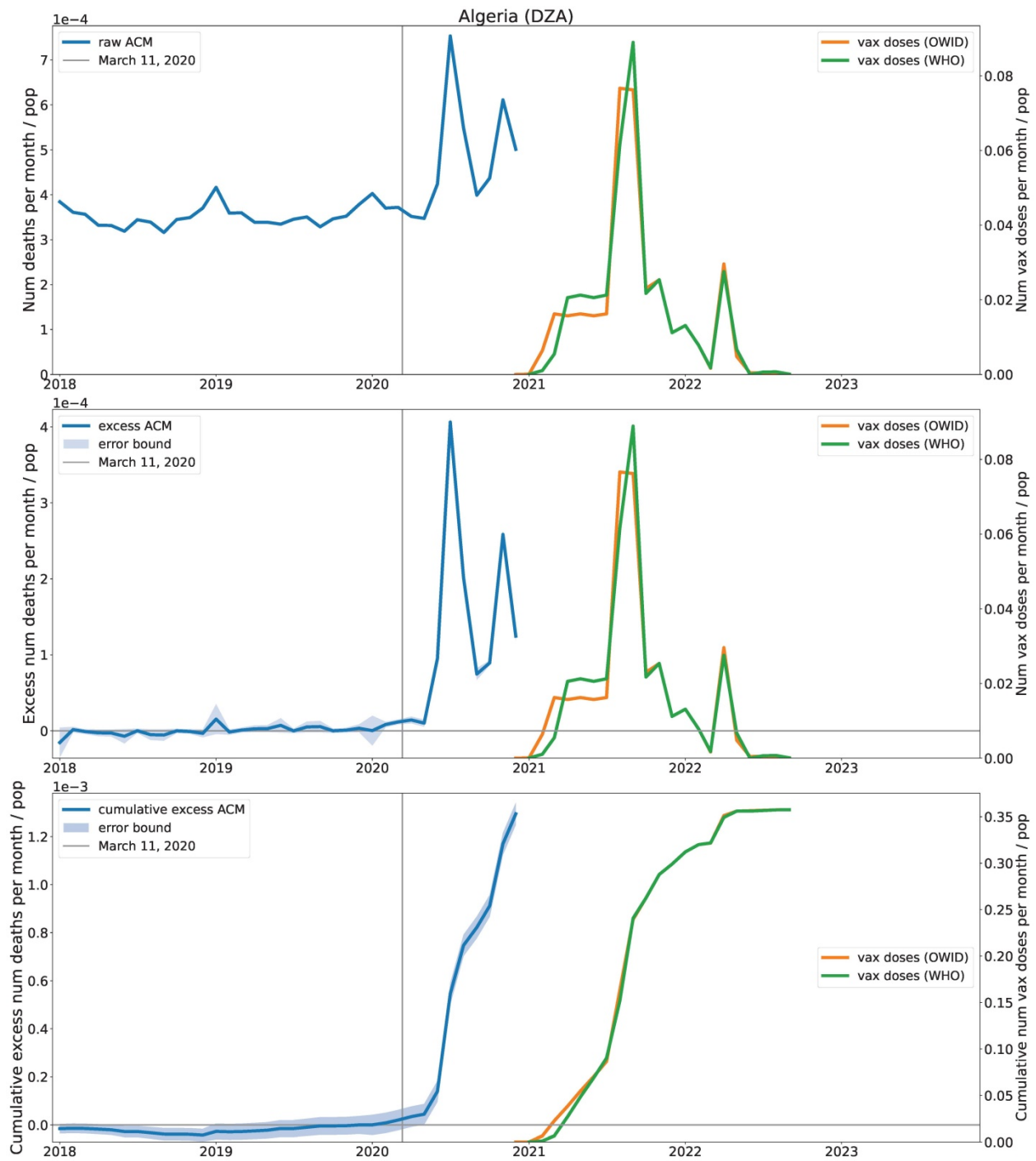
Top subpanel: Reported all-cause mortality by week or by month (blue line), and COVID-19 vaccine doses administered by week or by month (from different sources, as labelled), 2018-2023, both normalized by the national population in 2019.

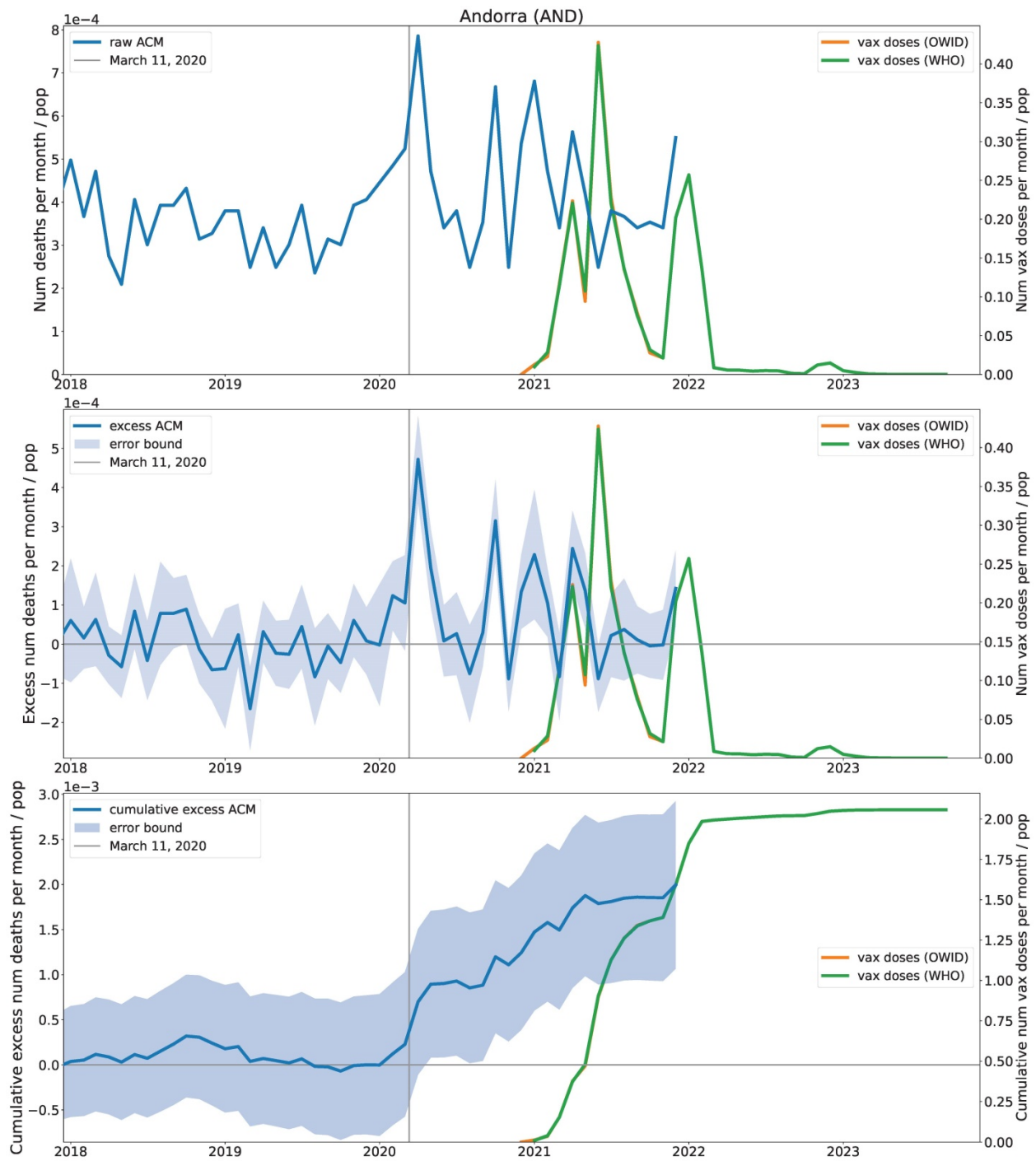
Middle subpanel: Calculated excess all-cause mortality, by week or by month (blue line), with 1σ error (shaded blue), and COVID-19 vaccine doses administered by week or by month (from different sources, as labelled), 2018-2023, both normalized by the national population in 2019.

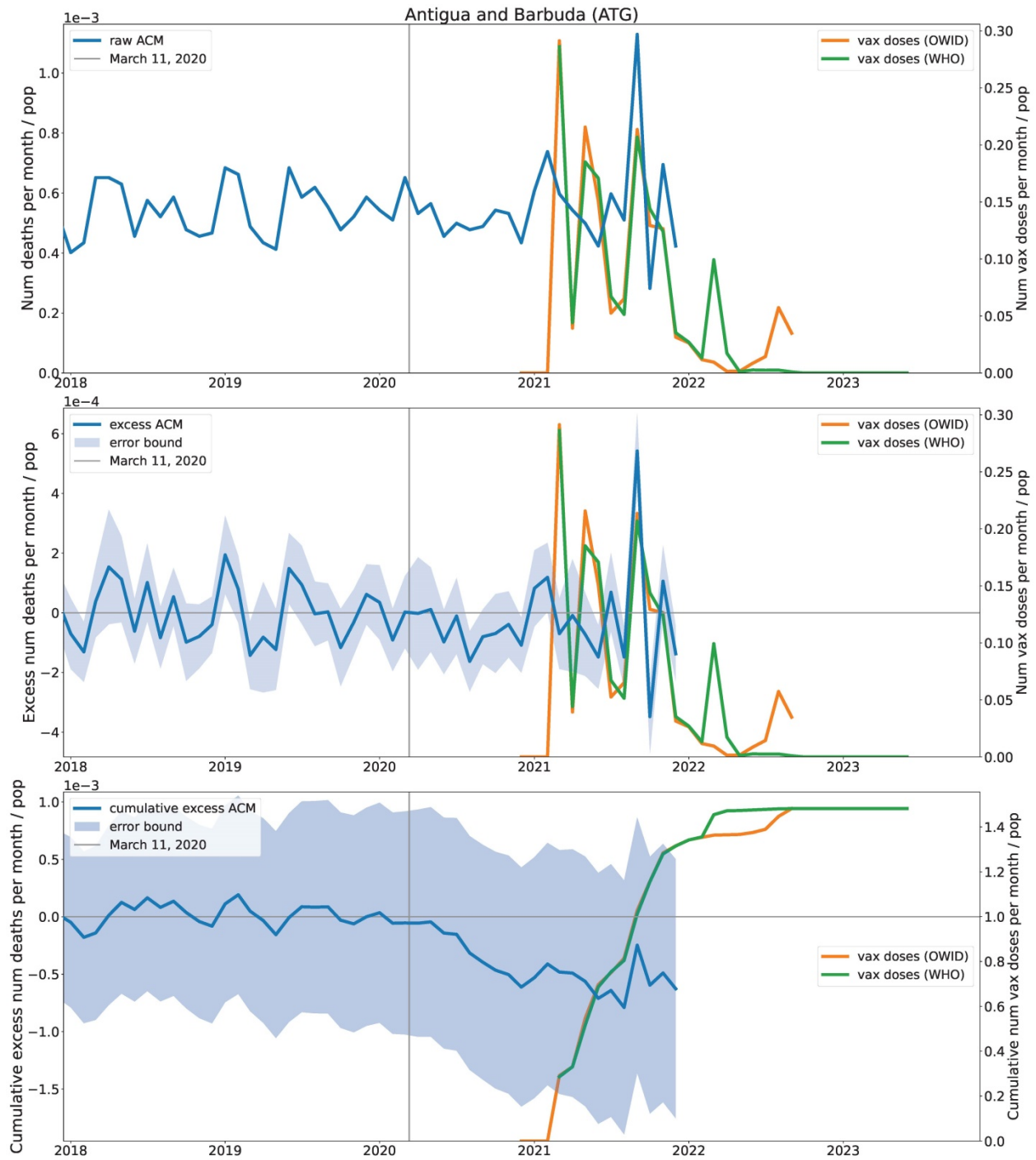
Bottom subpanel: Cumulative calculated excess all-cause mortality (blue line), by week or by month, with 1σ error (shaded blue), and cumulative COVID-19 vaccine doses administered by week or by month (from different sources, as labelled), 2018-2023, both normalized by the national population in 2019.

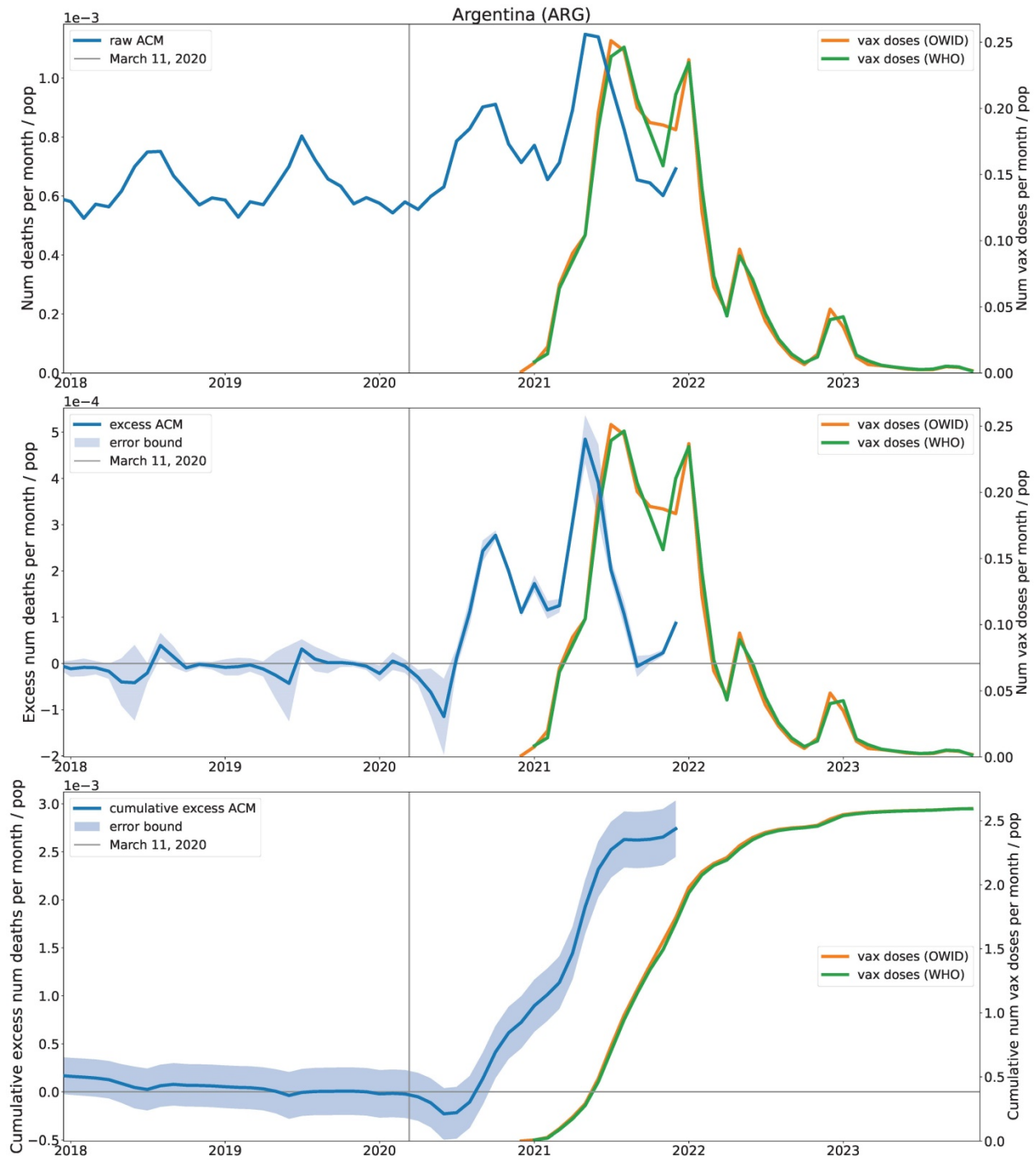
In the labels of axes and in legends in all figures, throughout the present article, “1e-4” or “1E-4” means “times 10^{-4} ”, and so forth (following scientific and computer-programming notation).

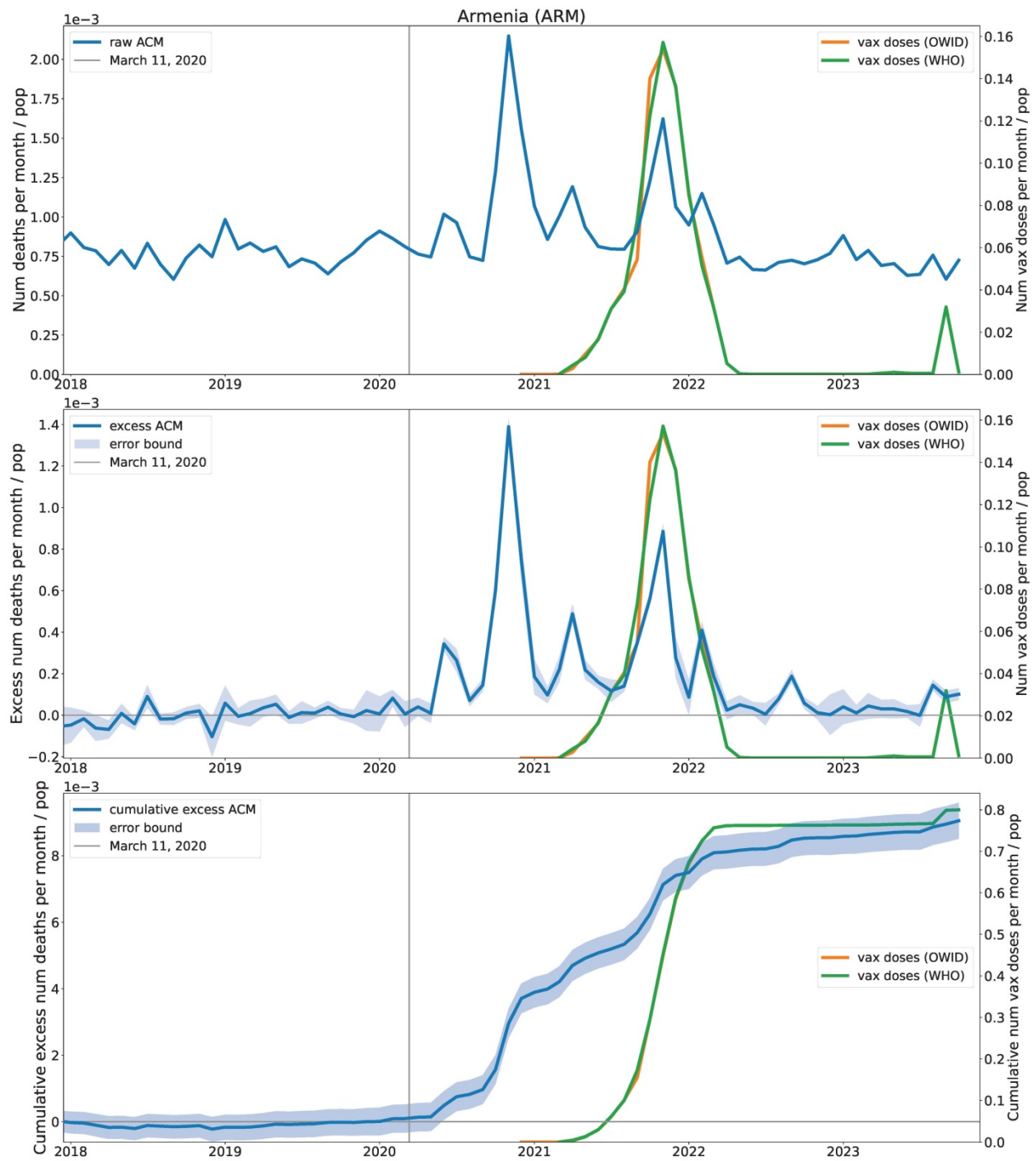


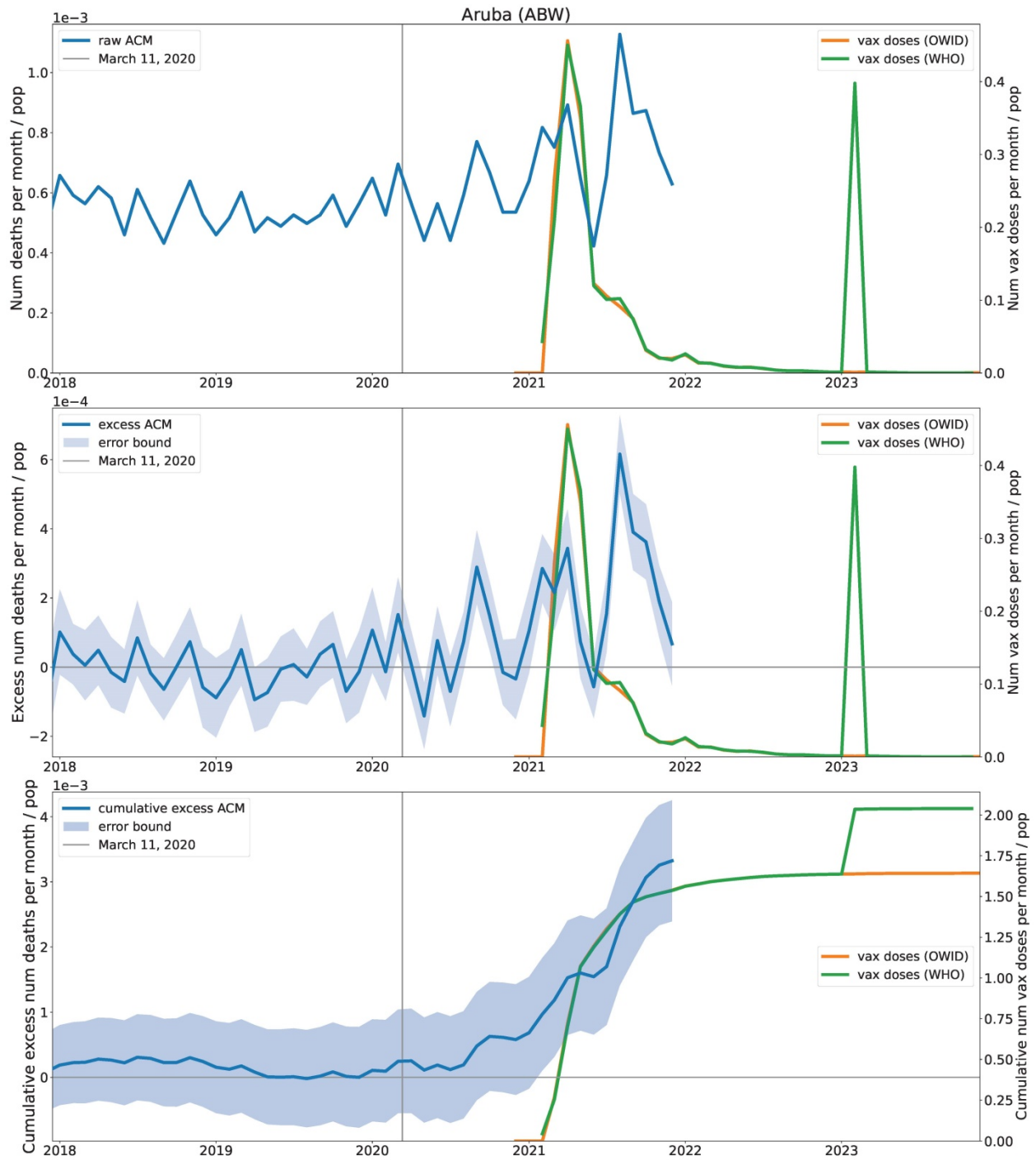


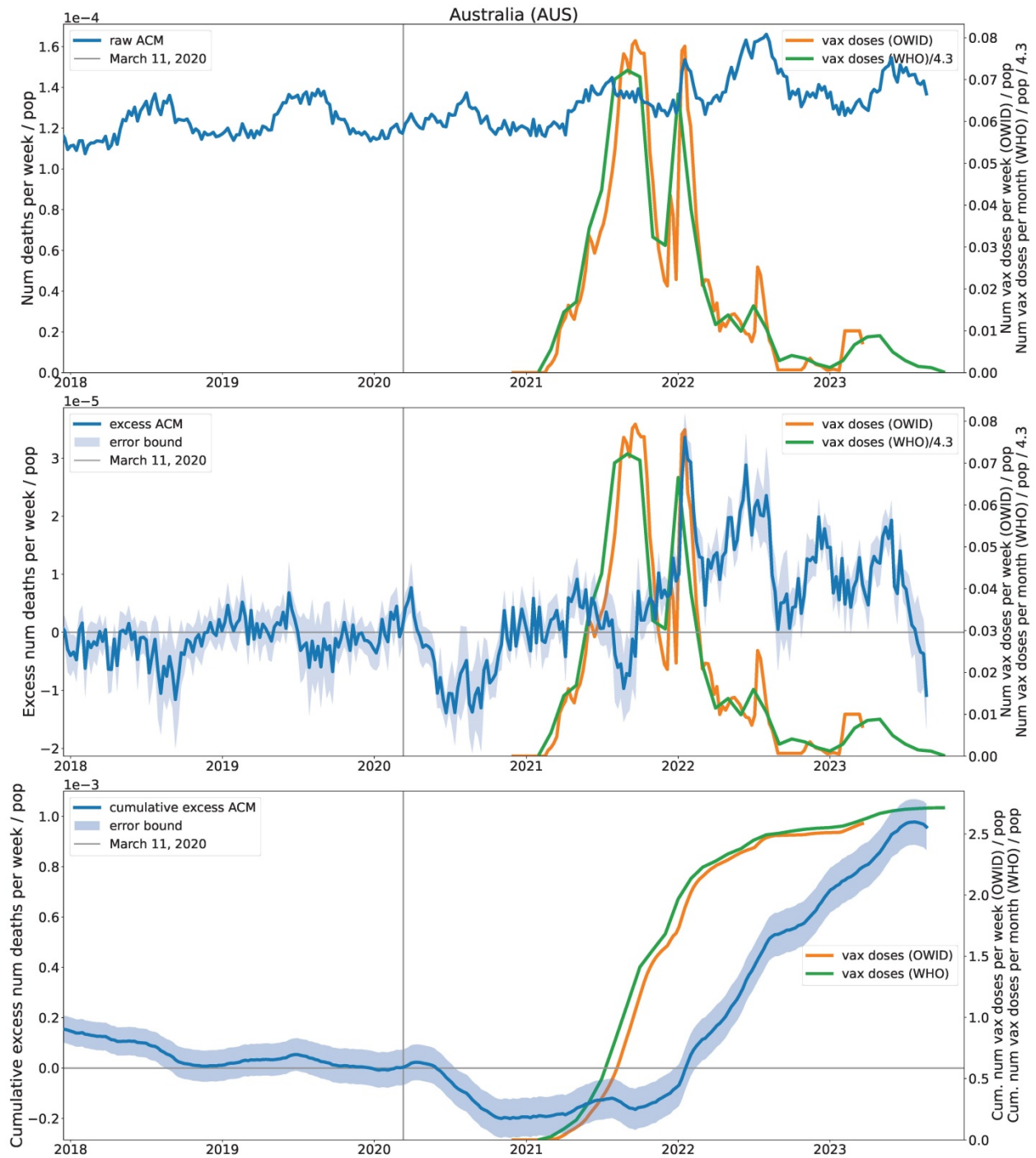


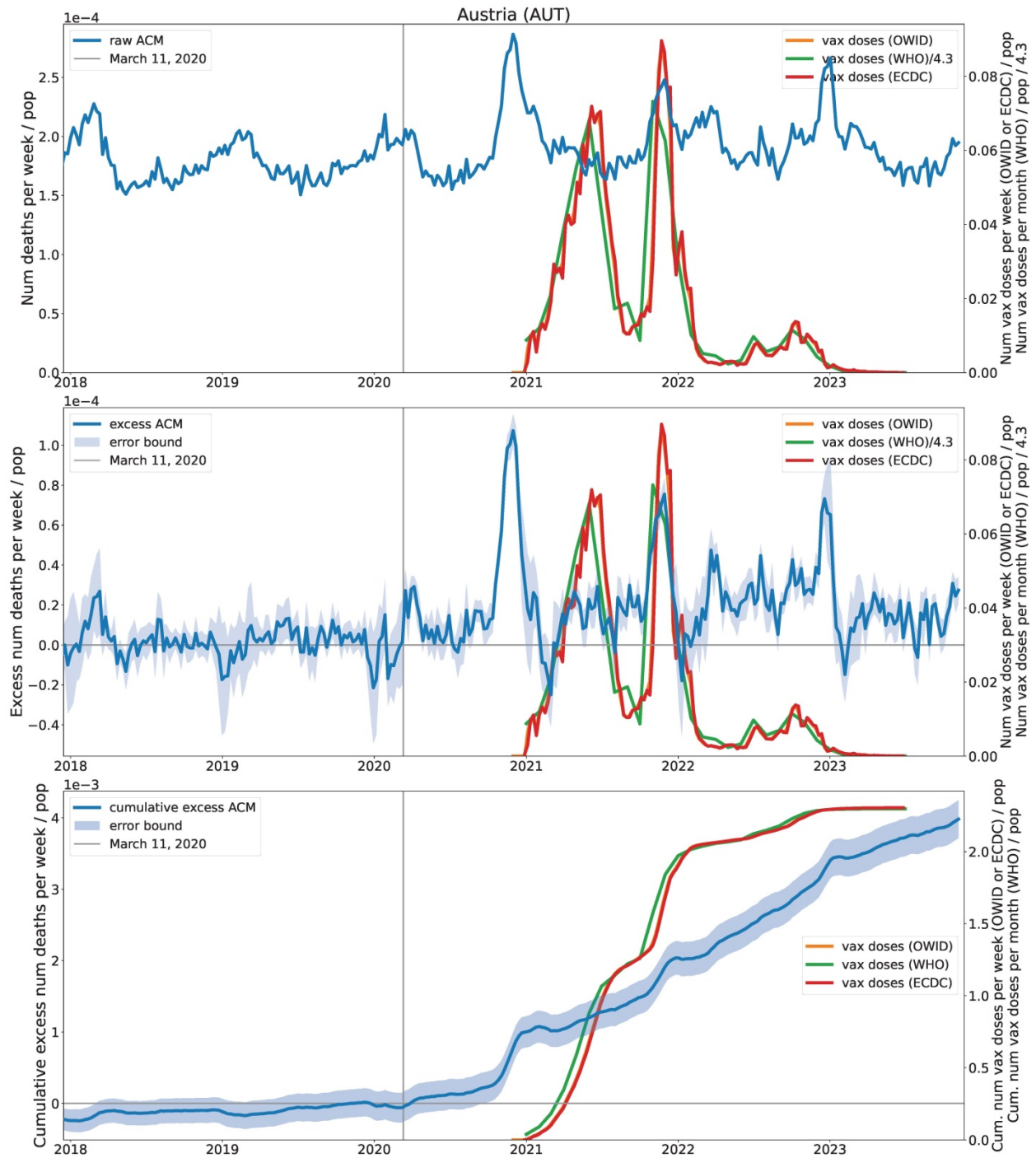


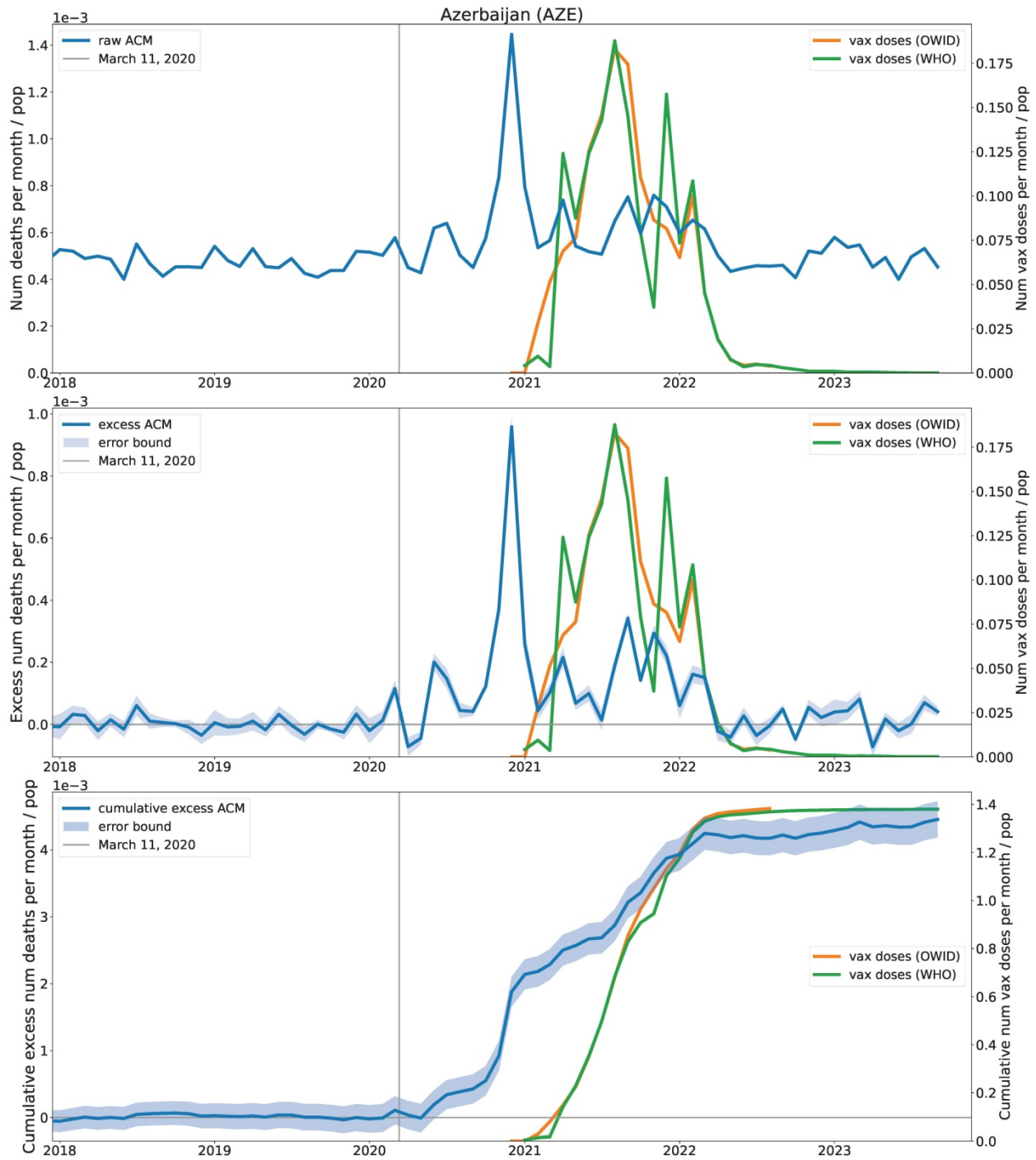


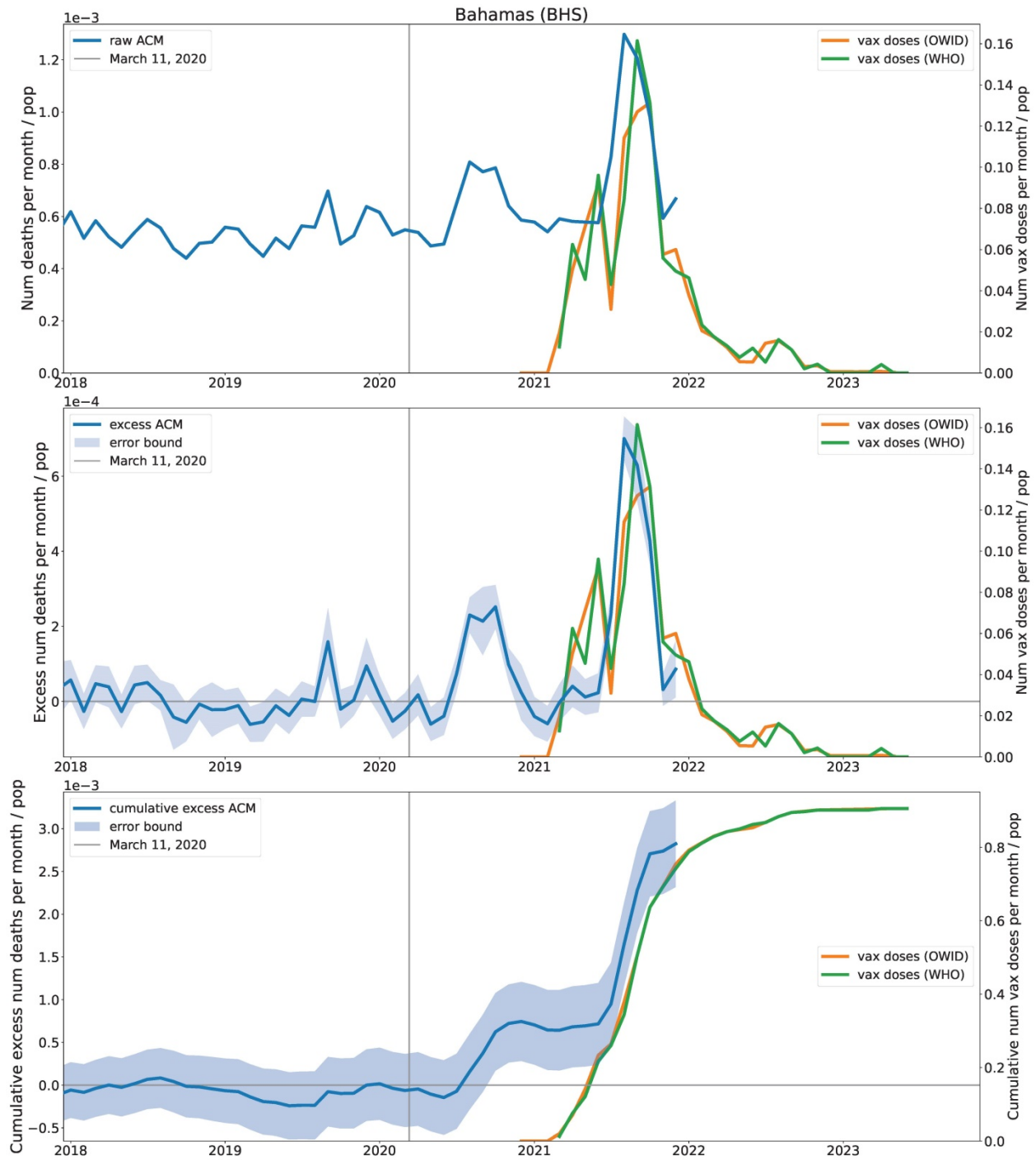


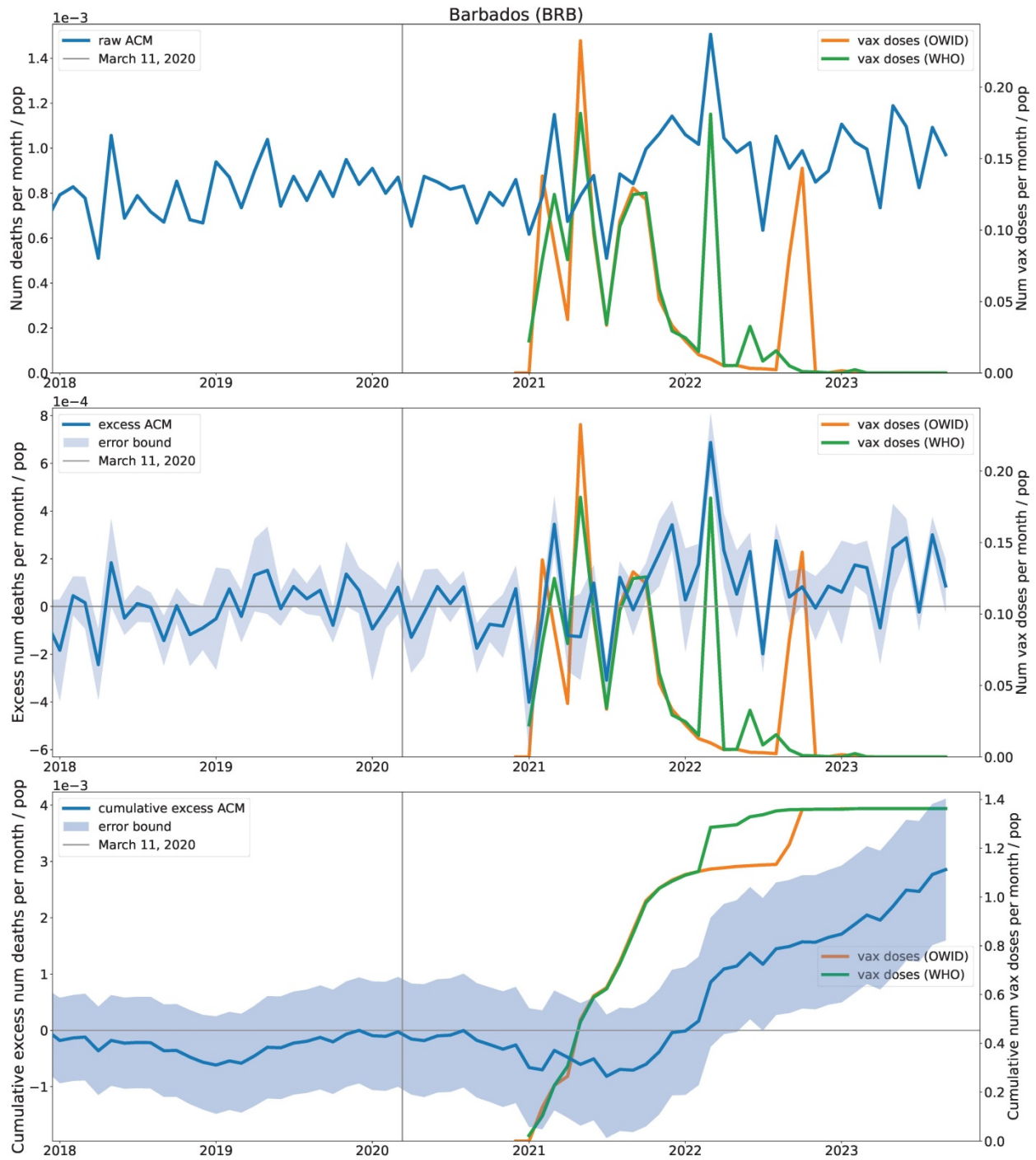


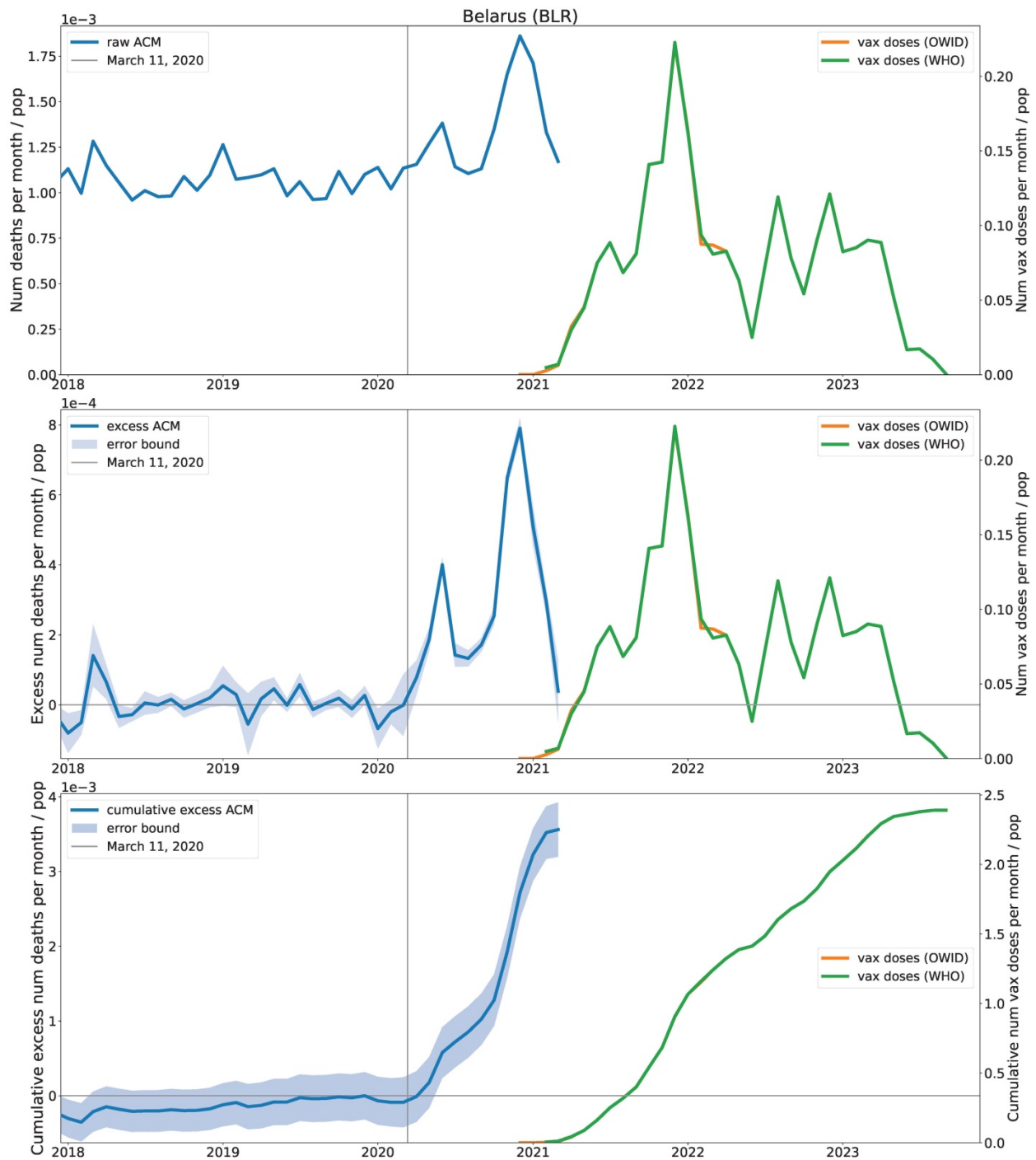


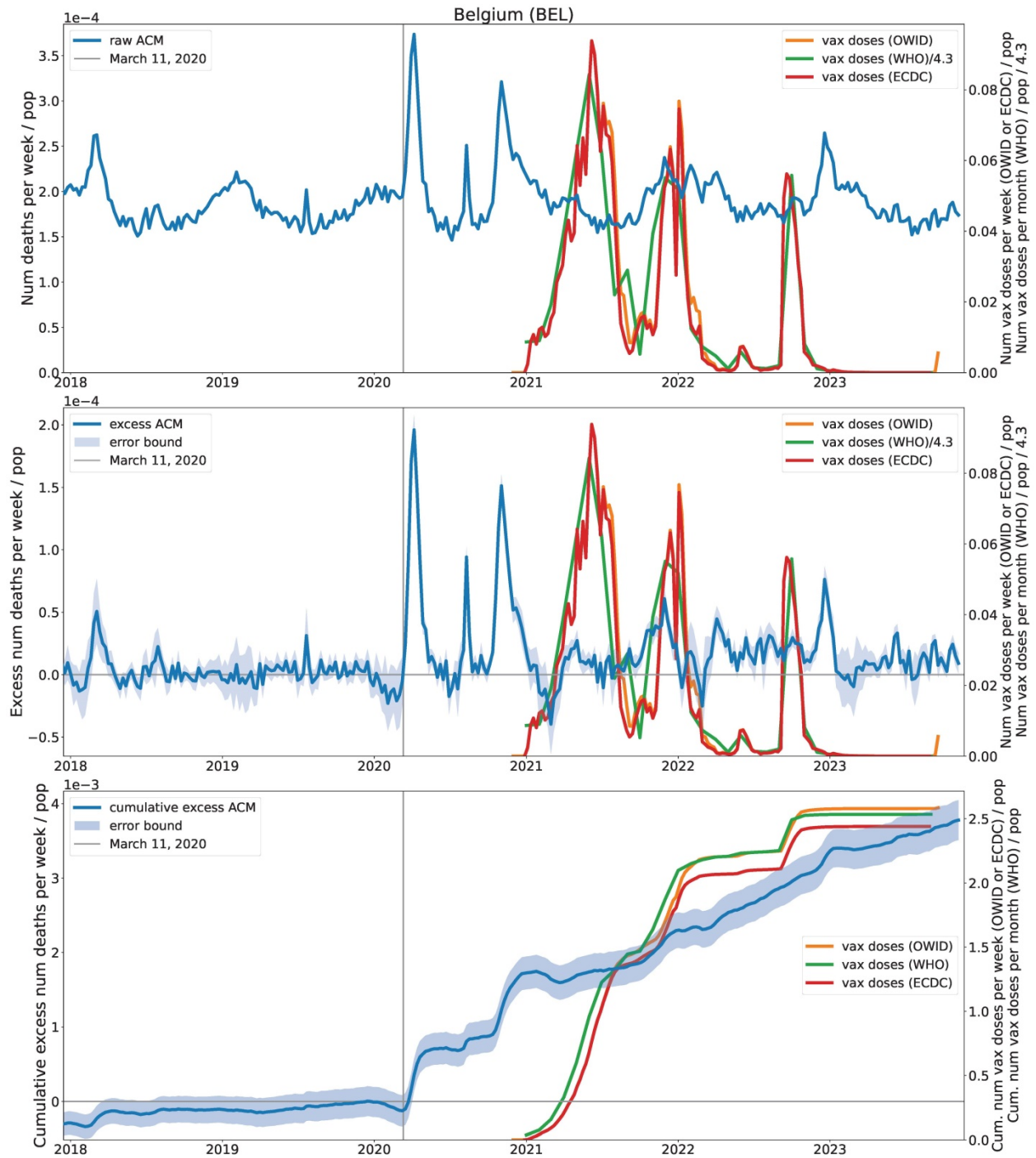


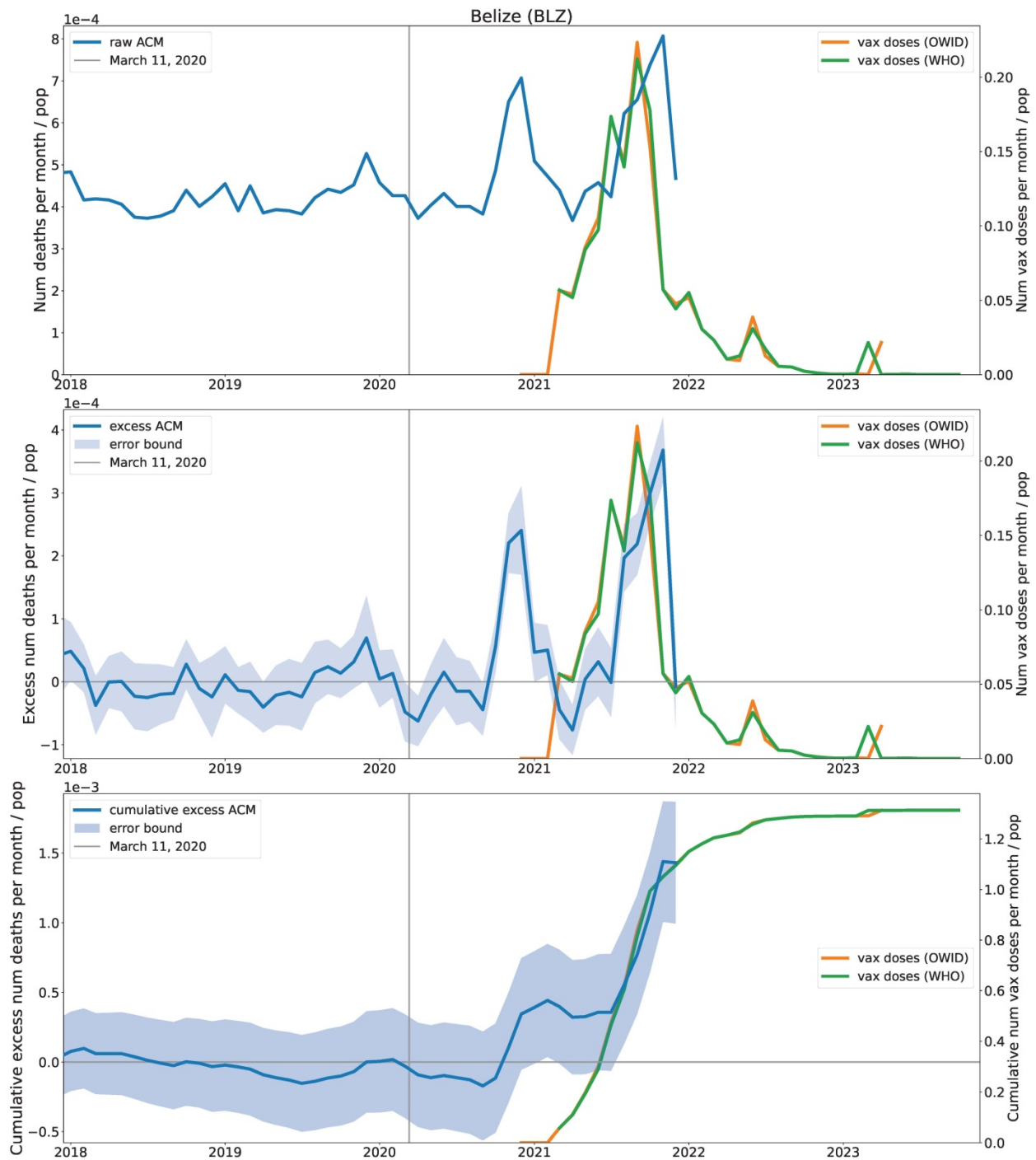


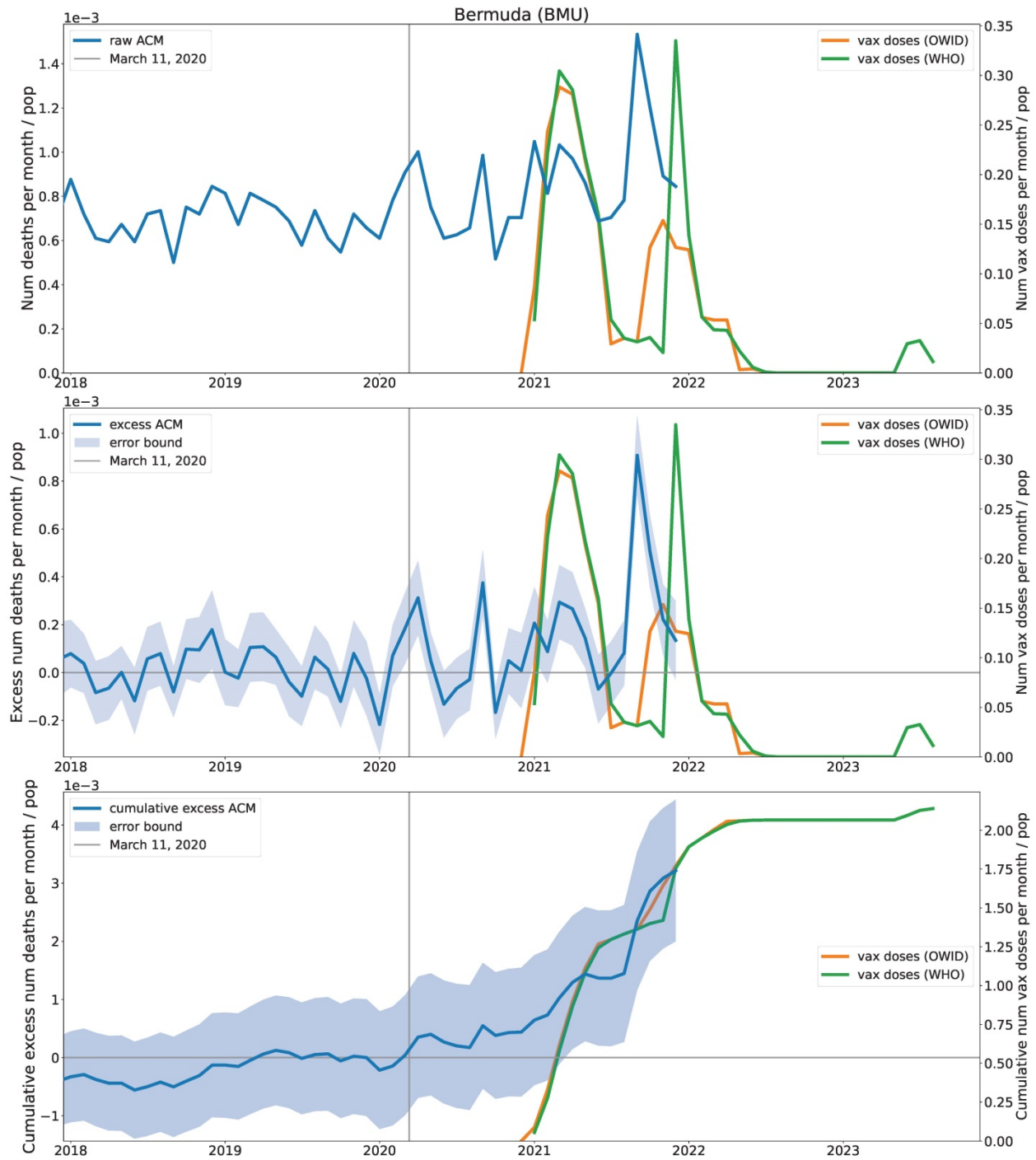


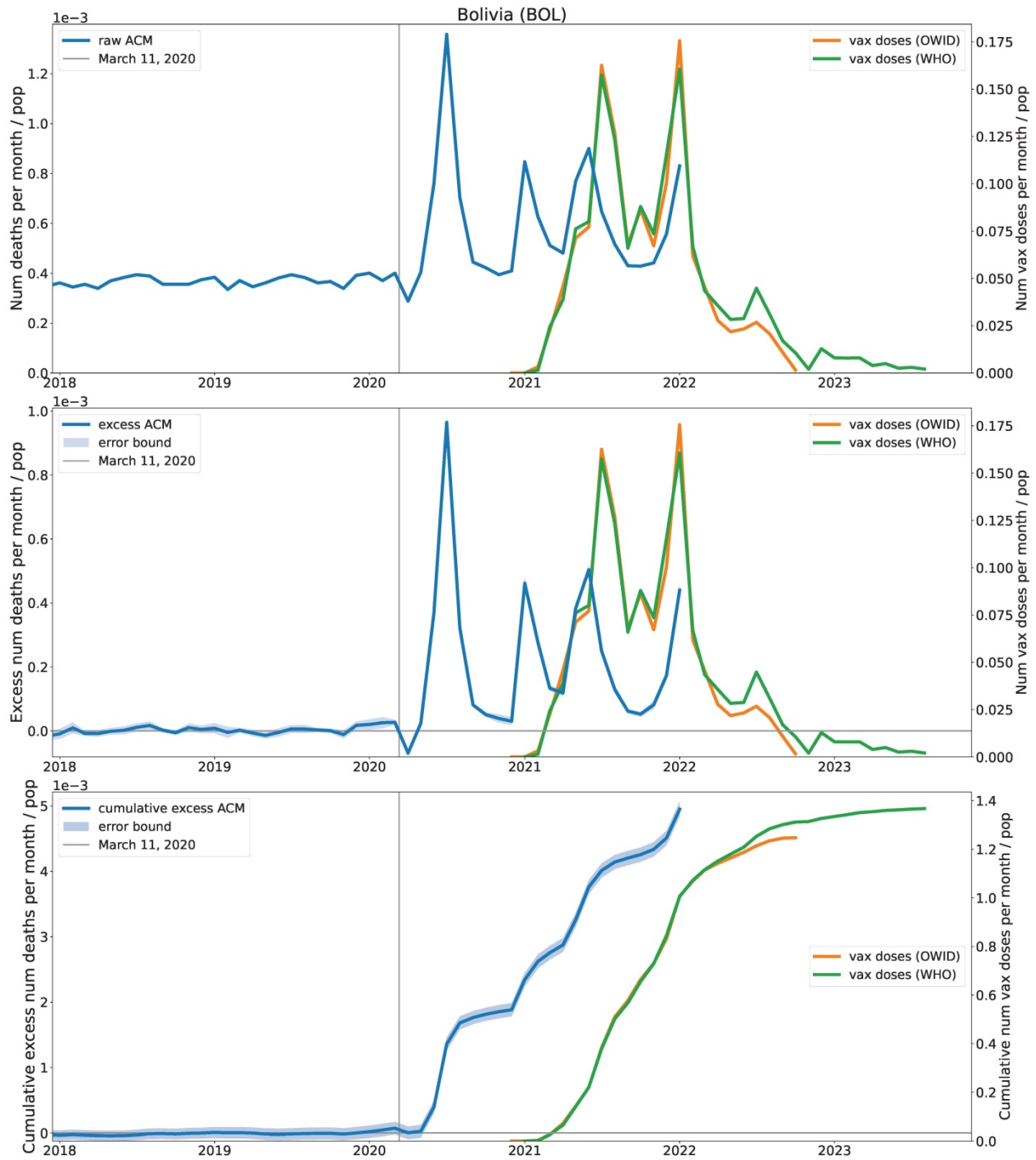


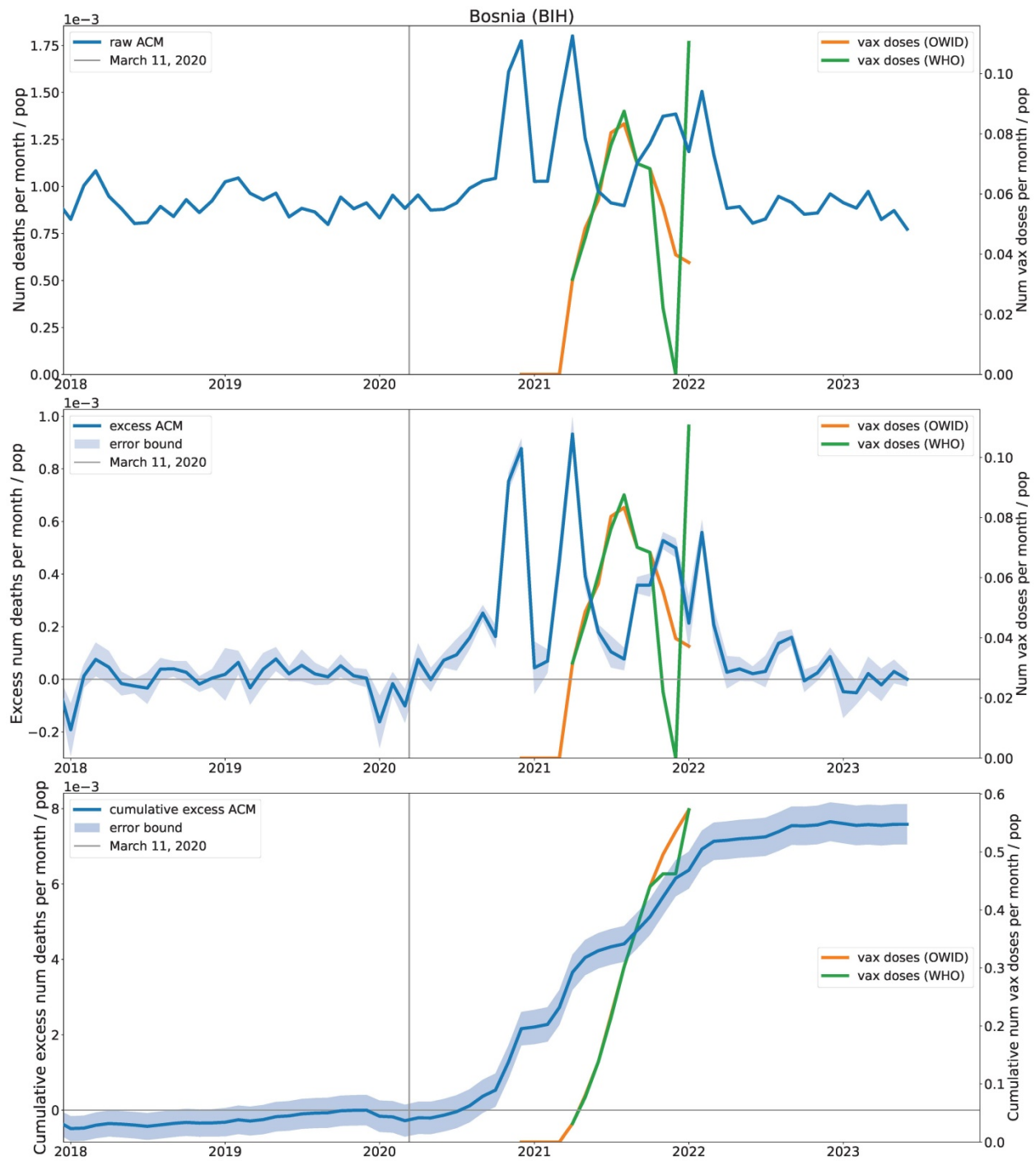


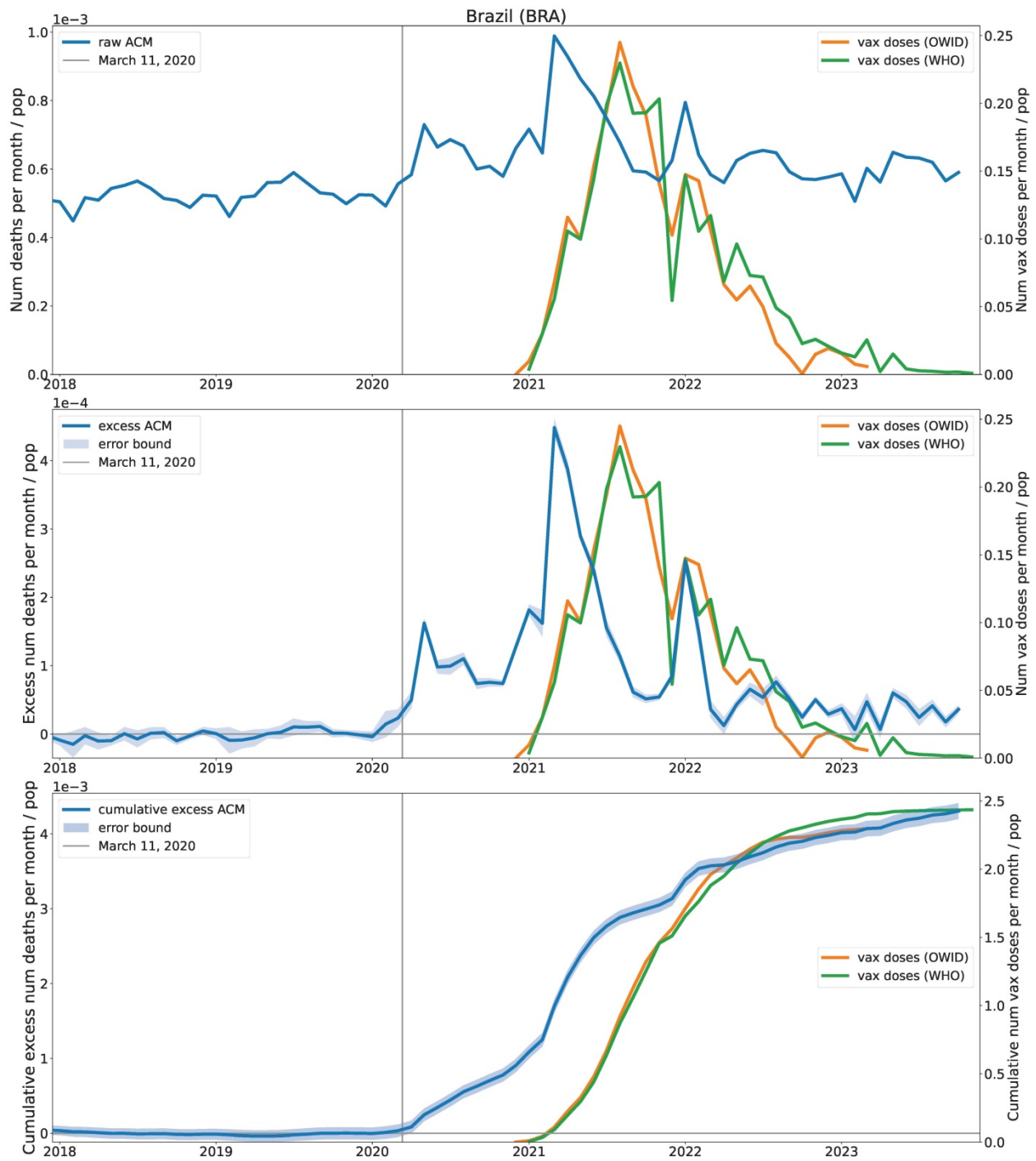


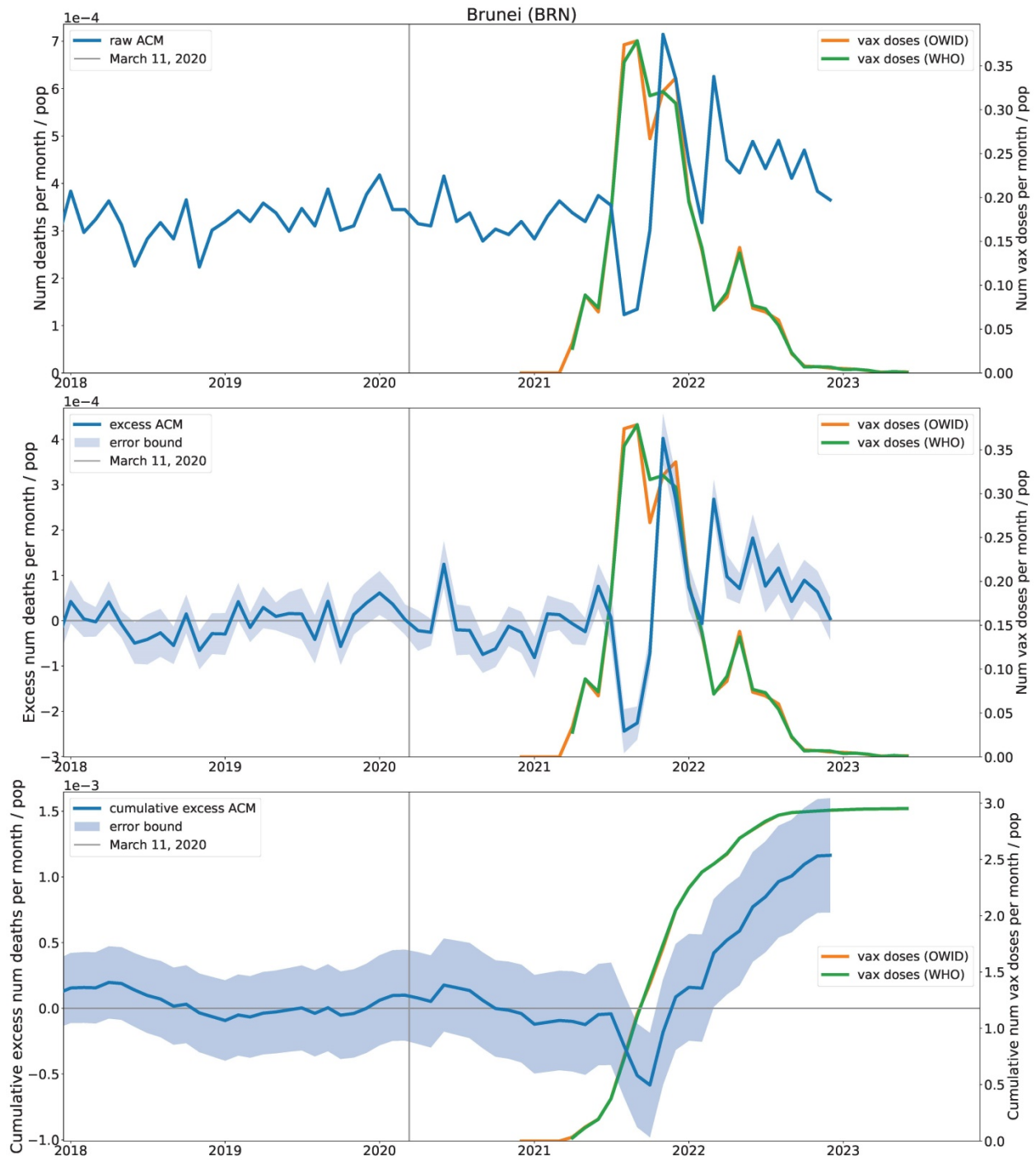


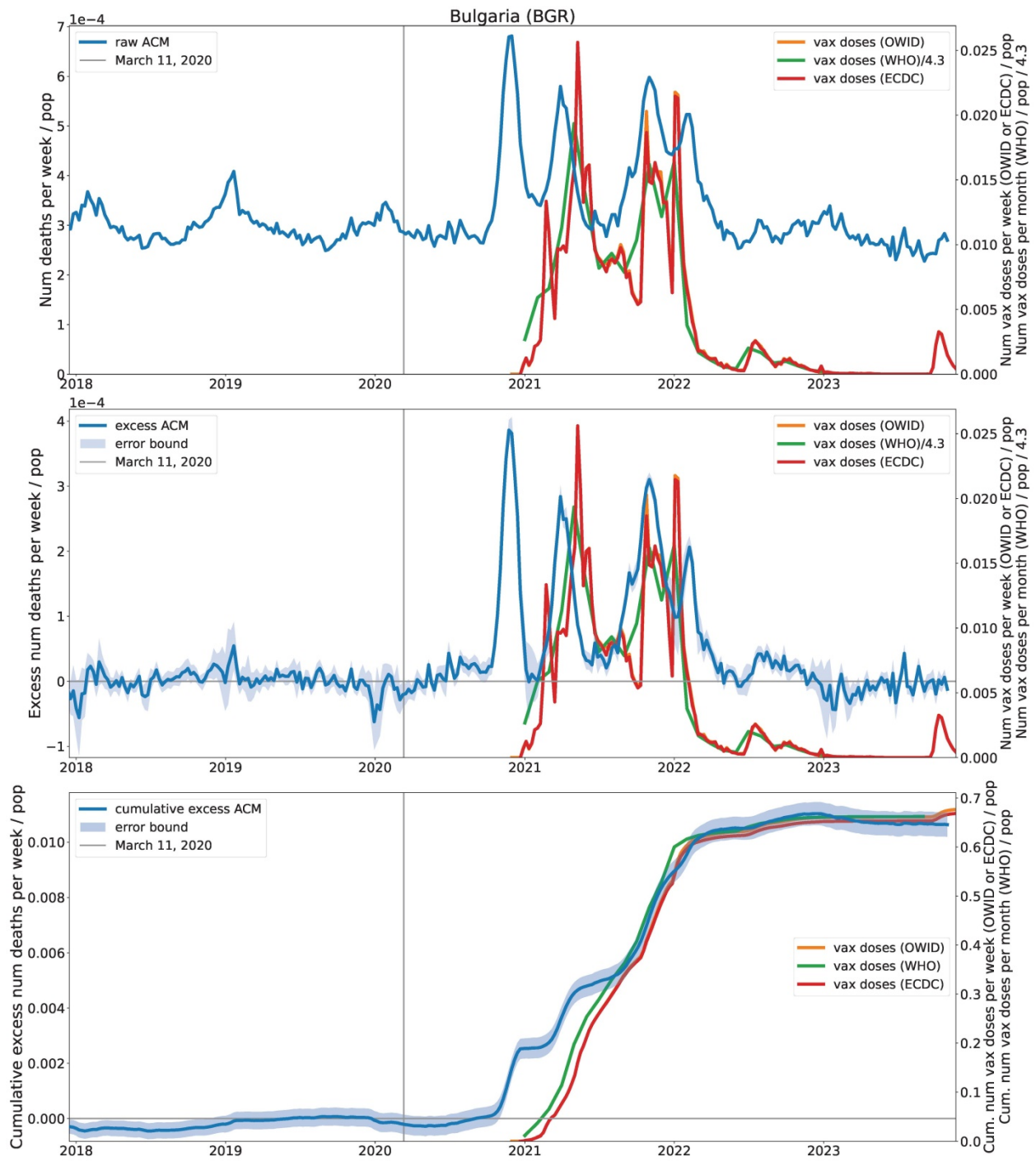


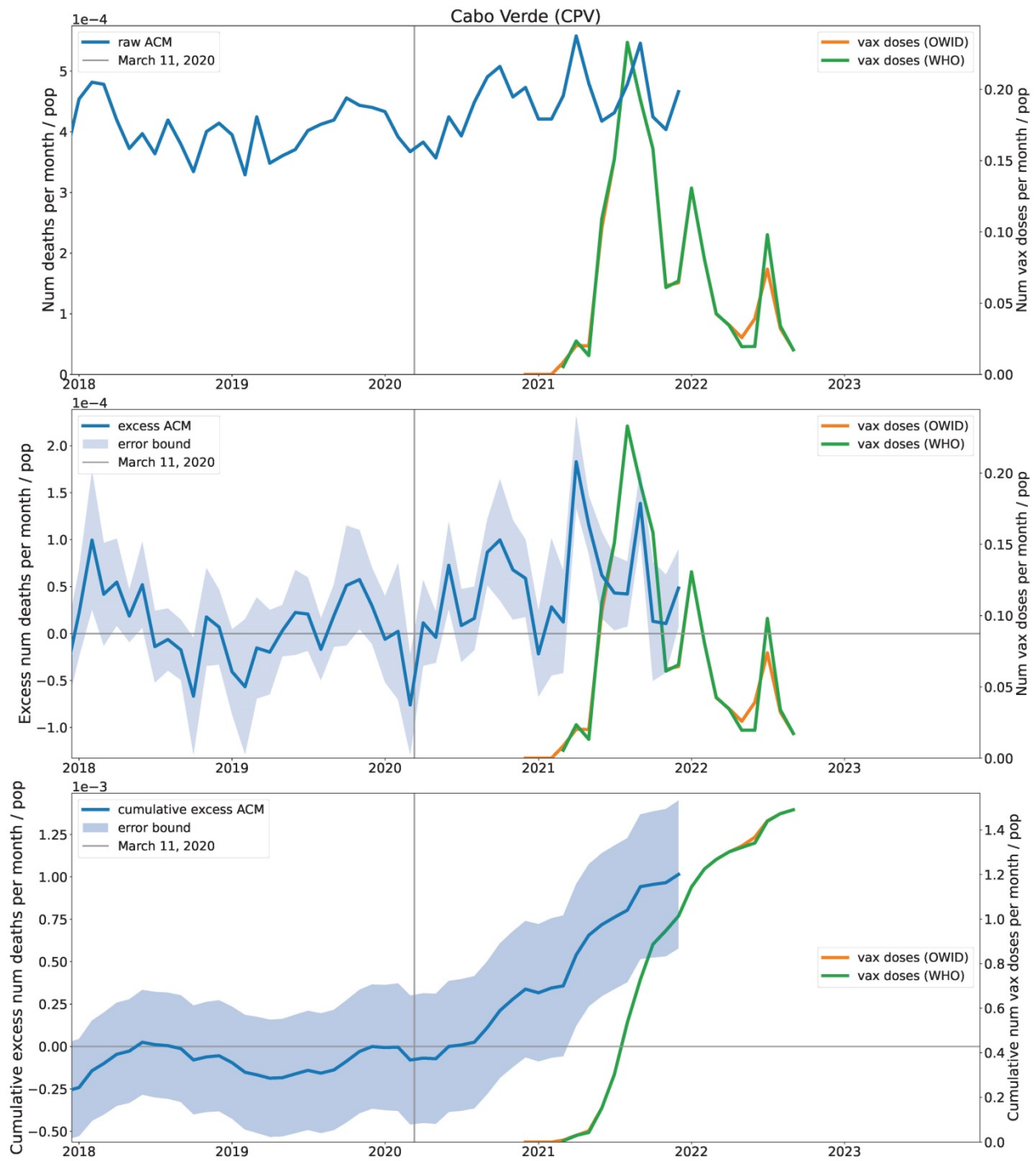


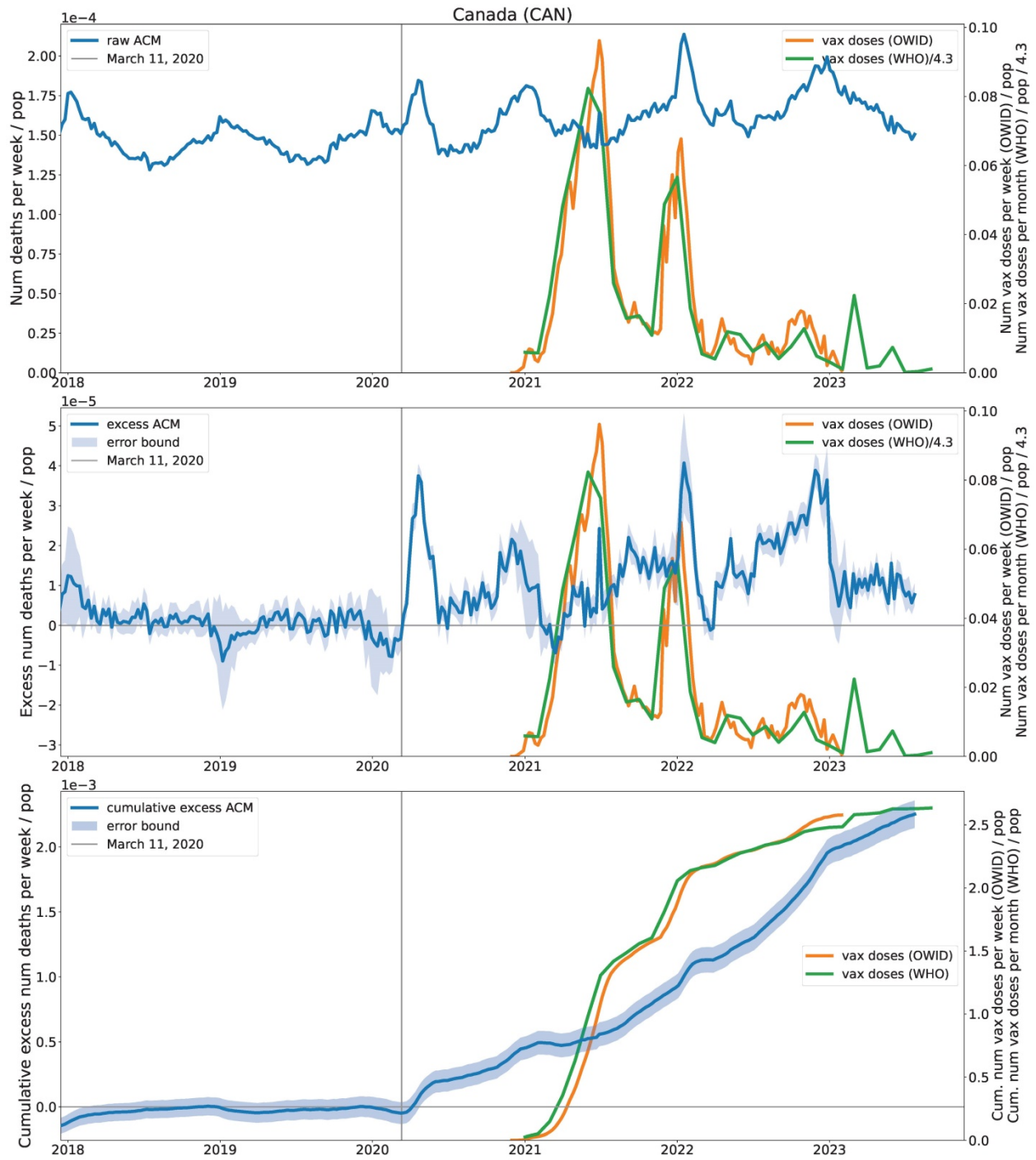


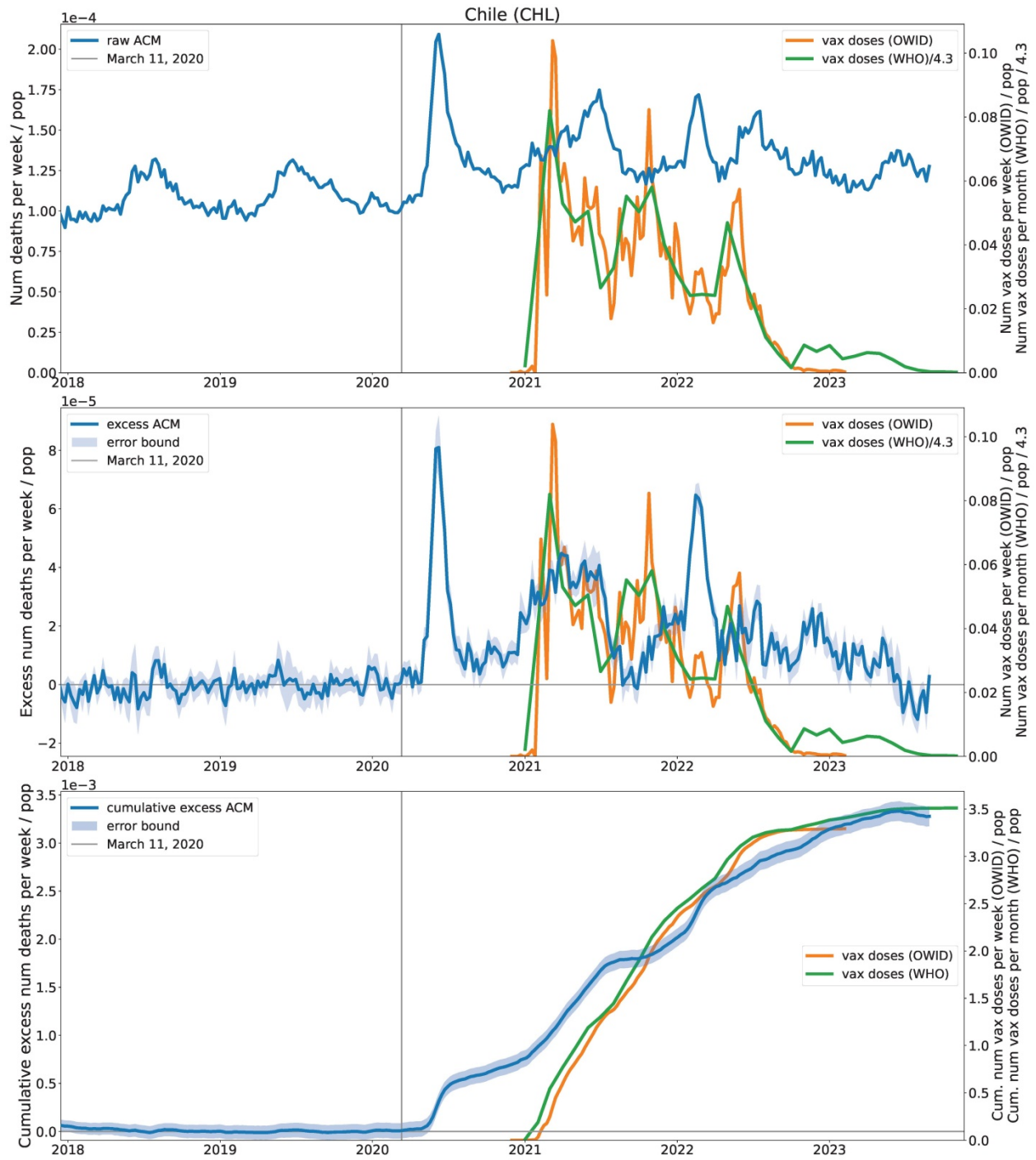


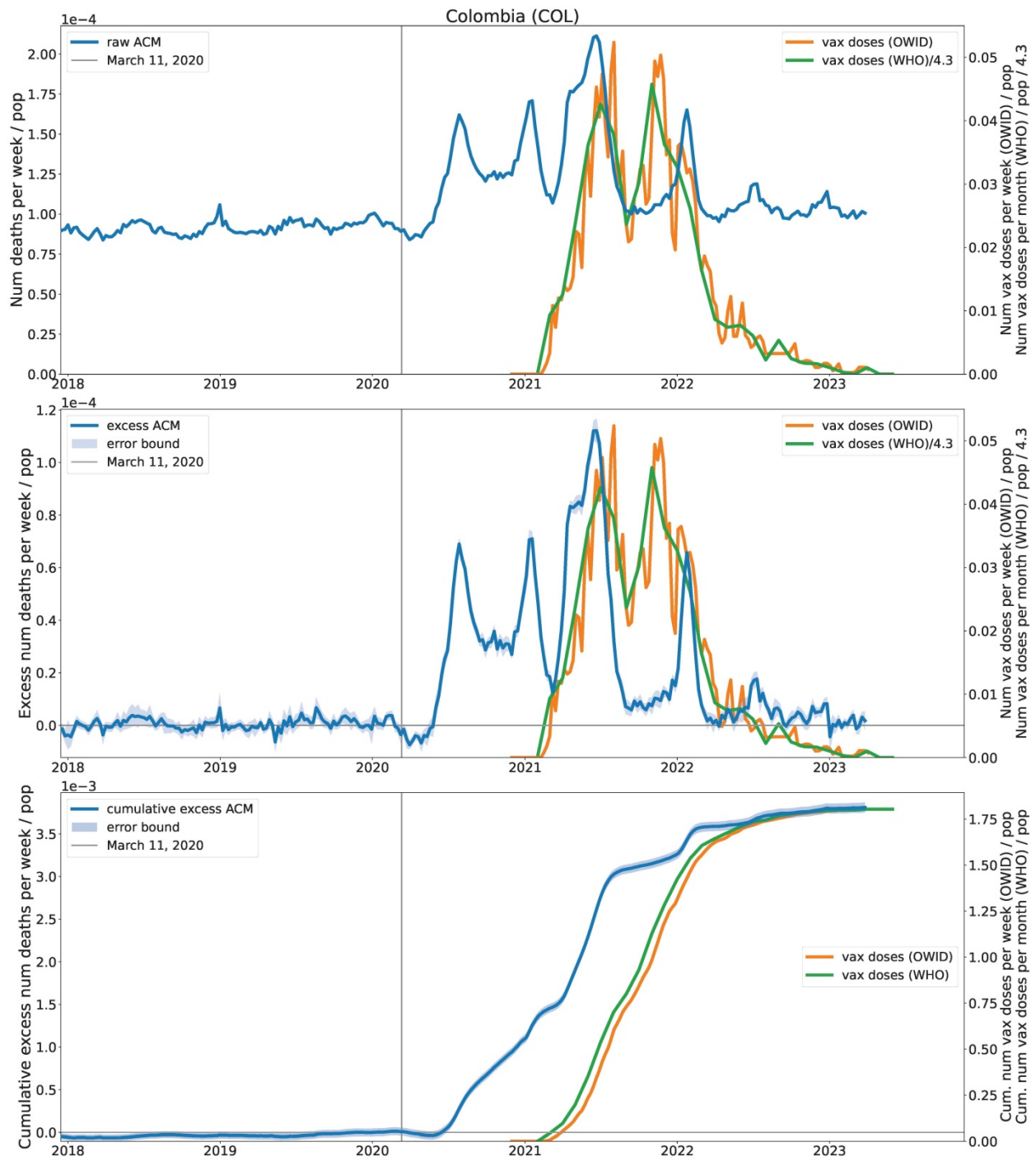


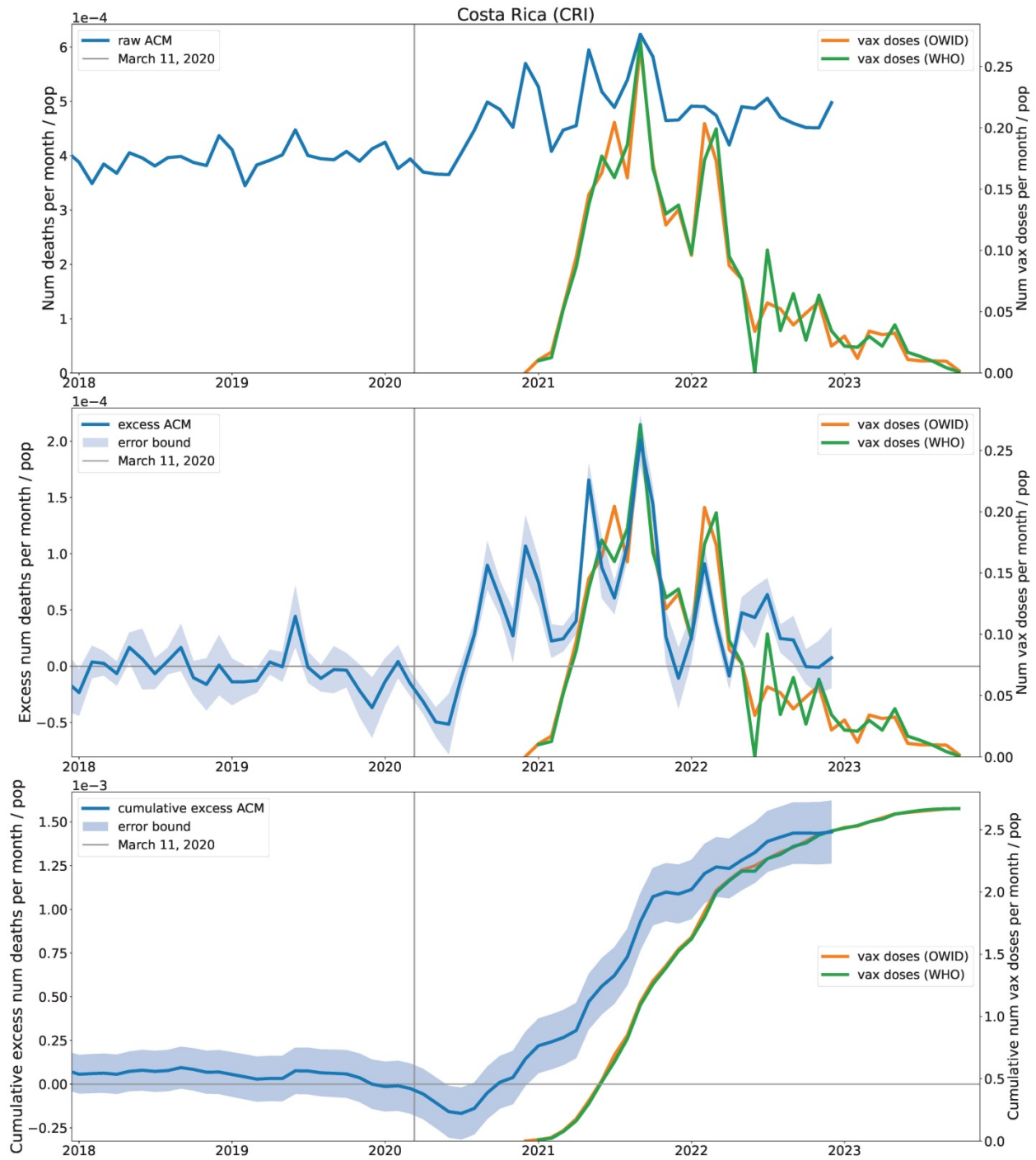


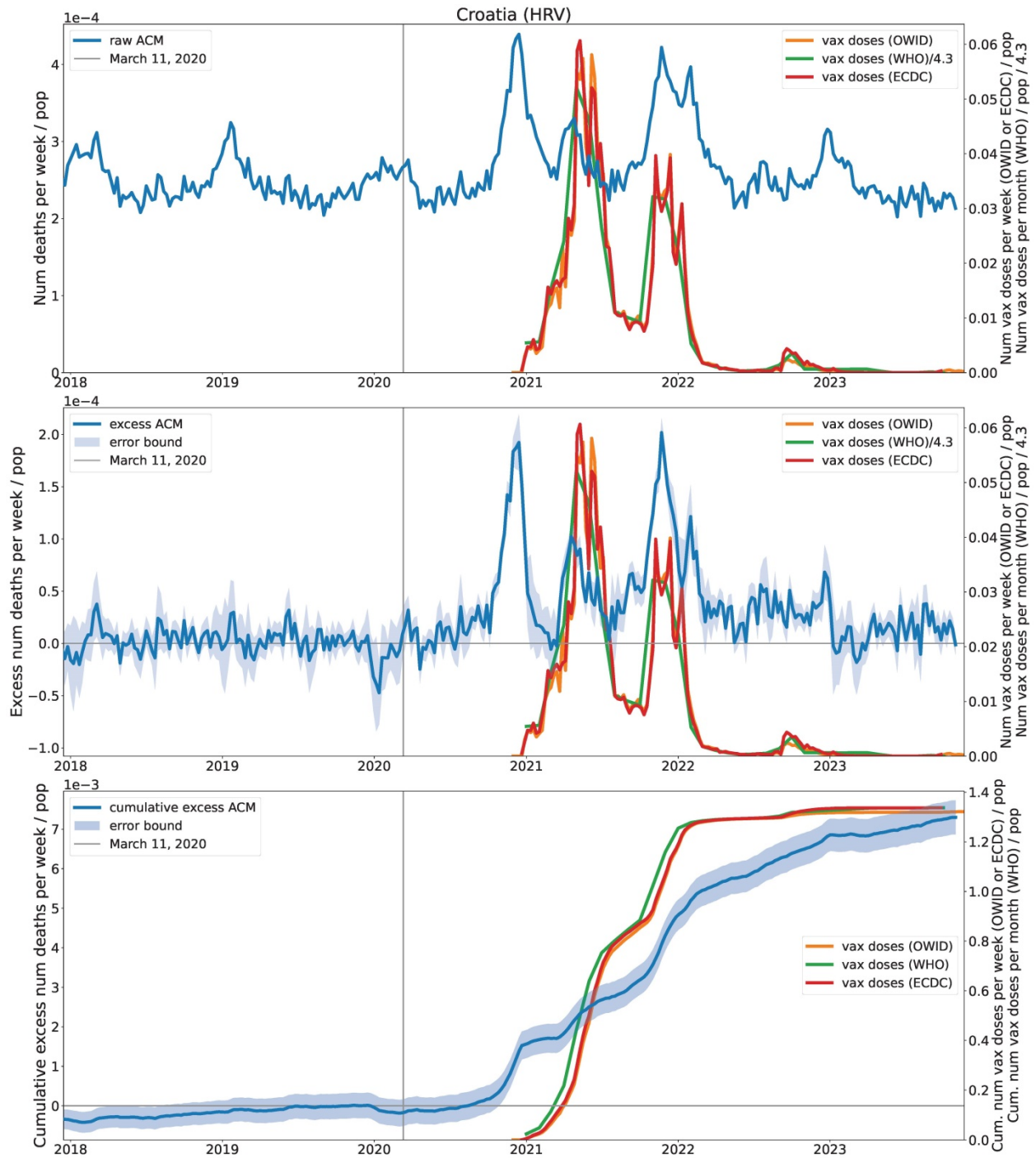


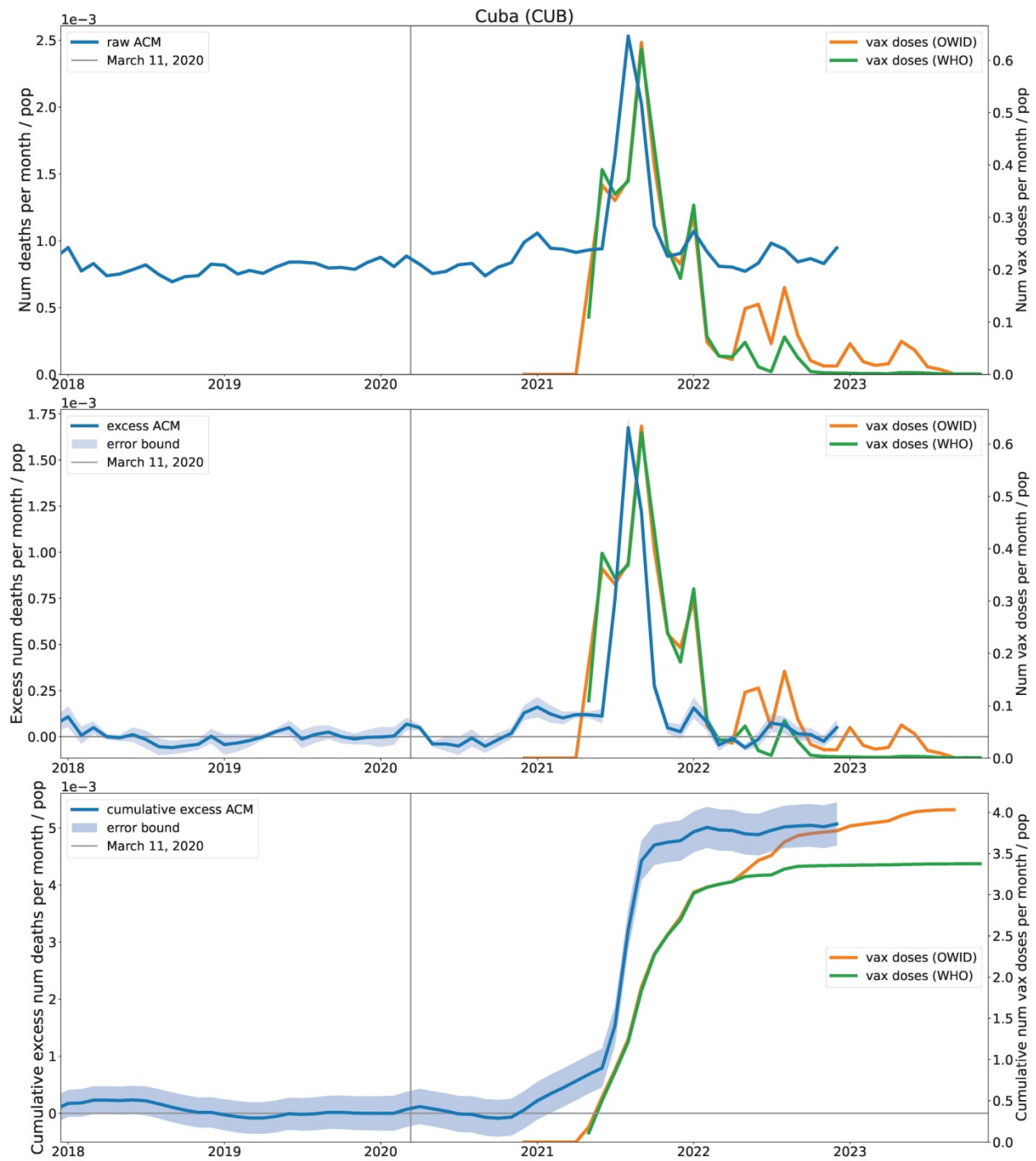


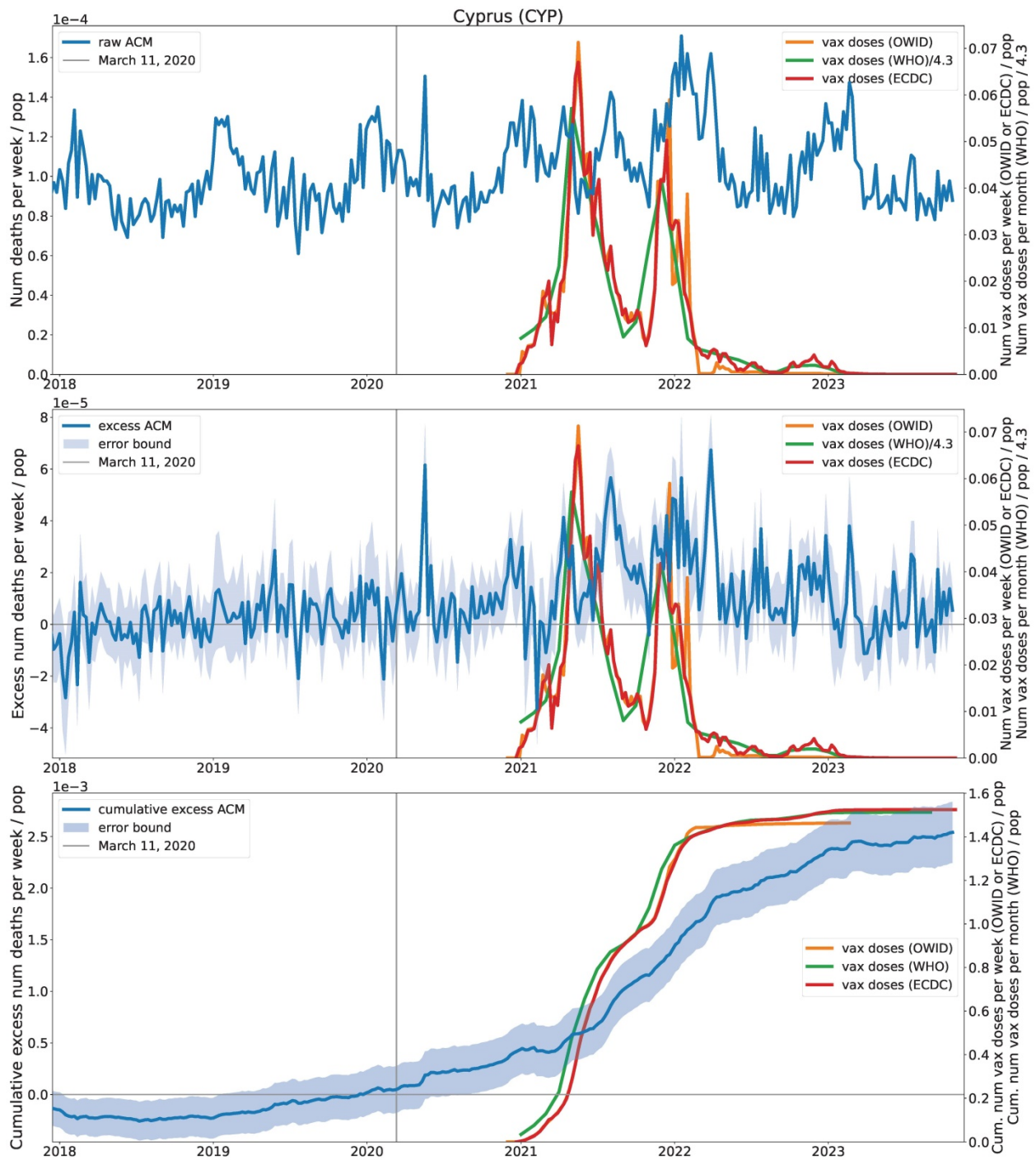


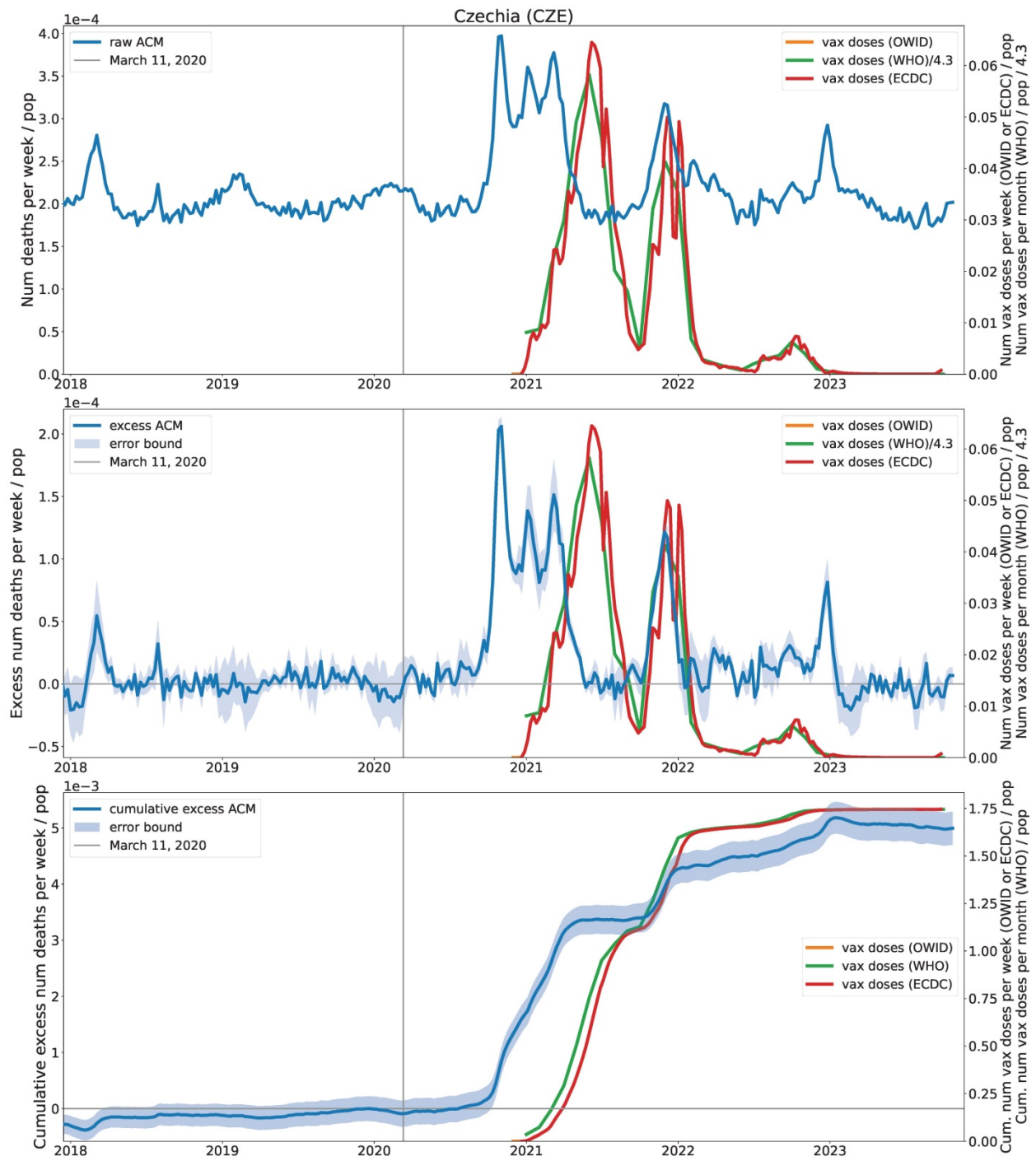


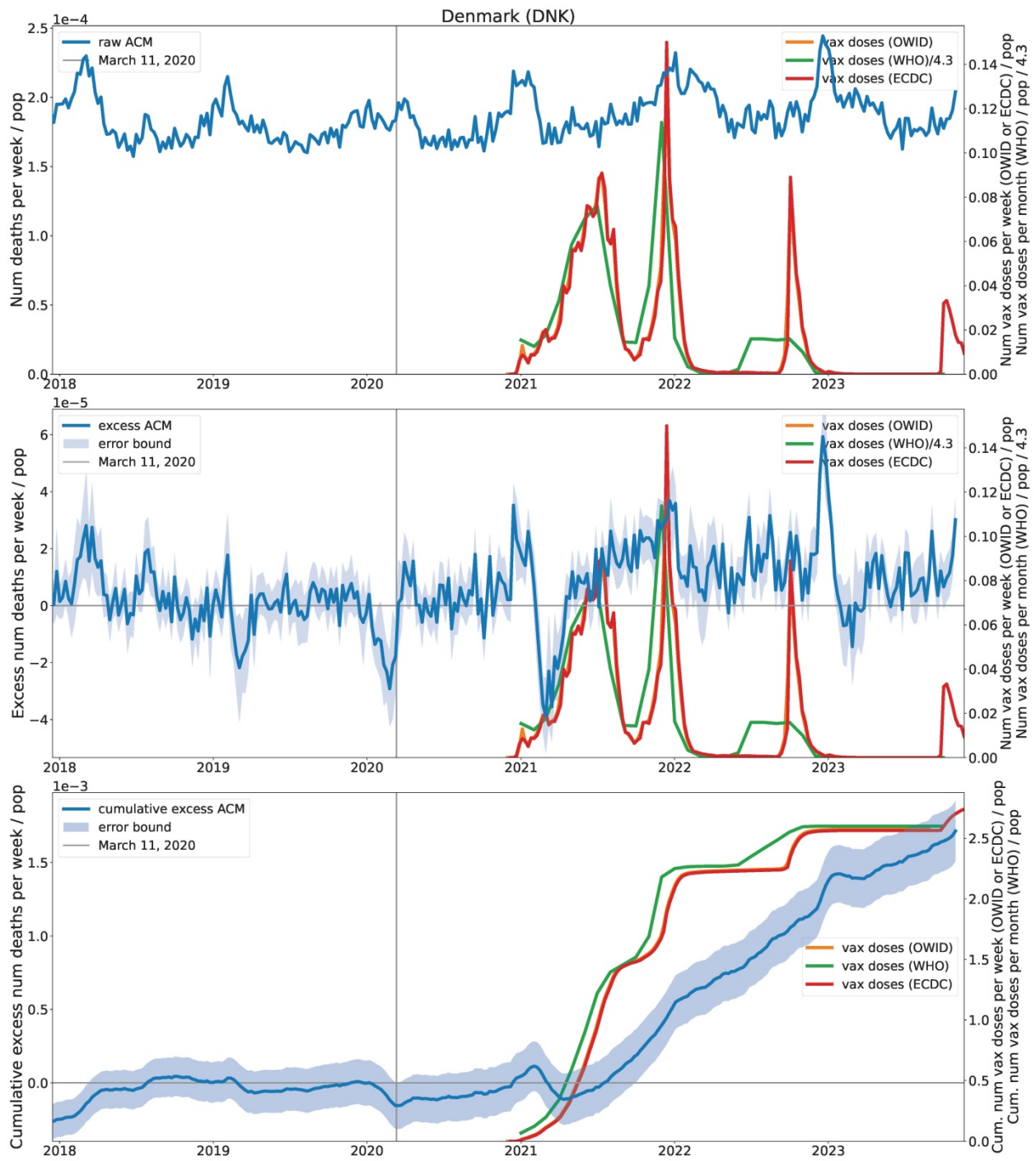


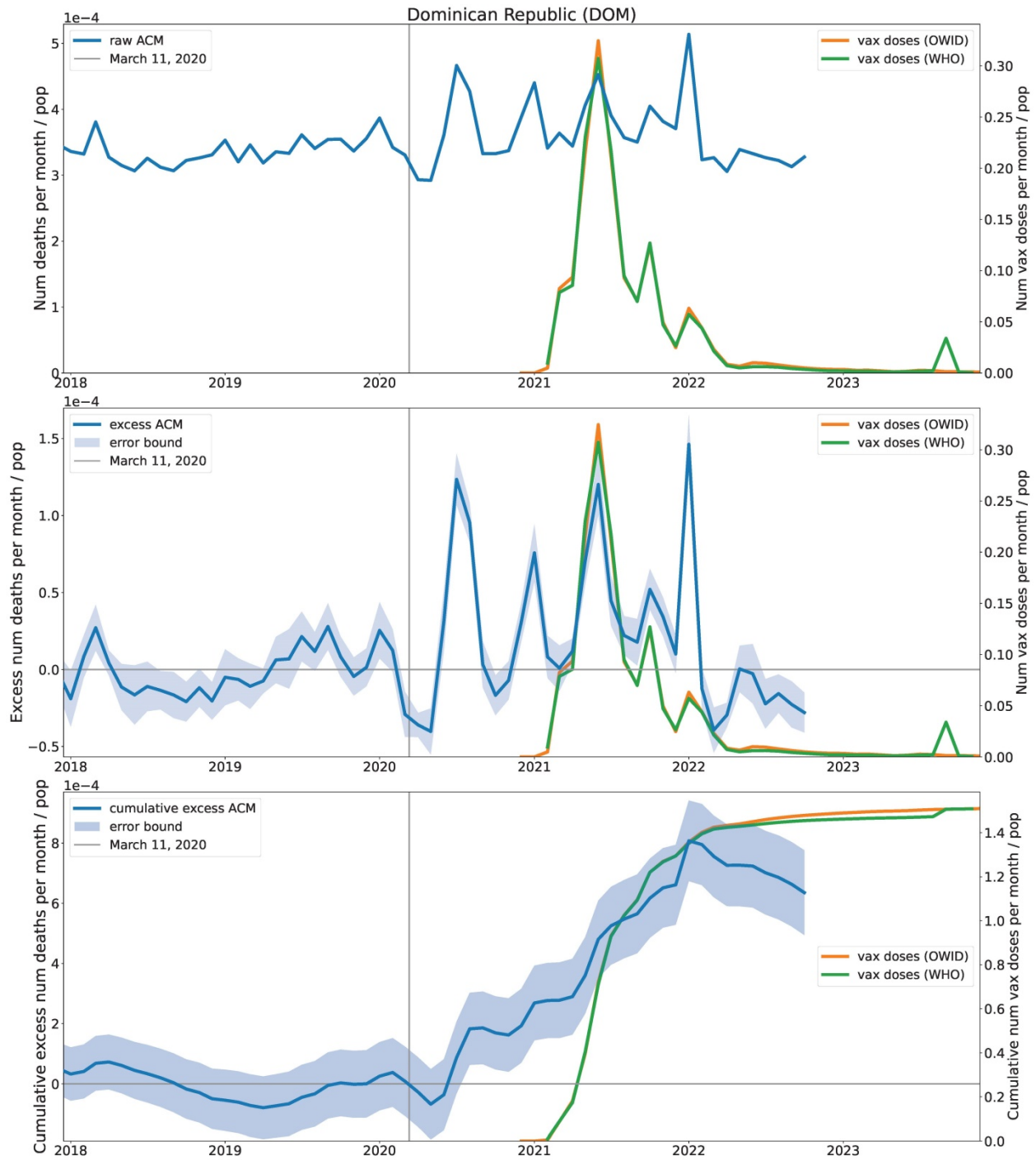


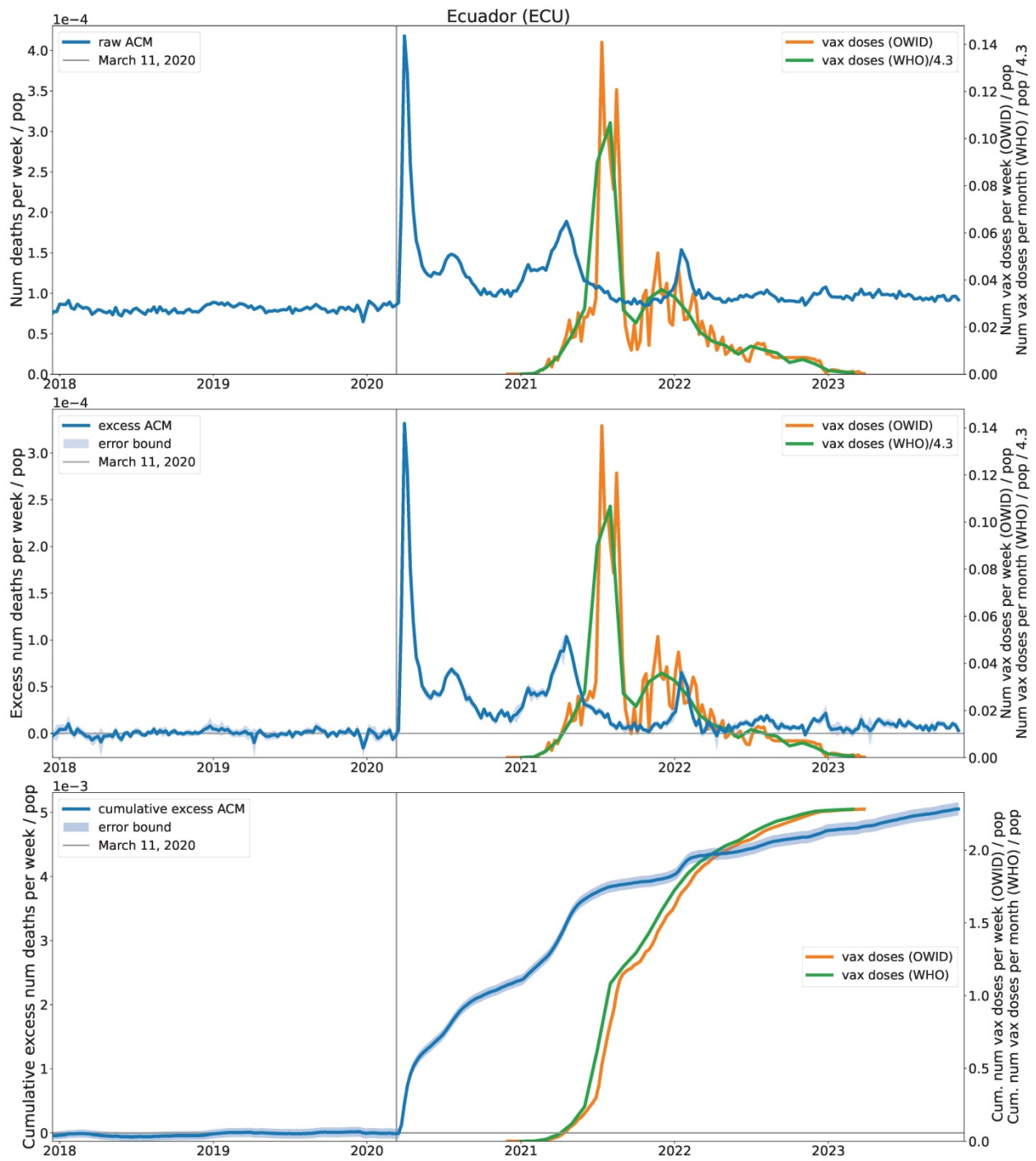


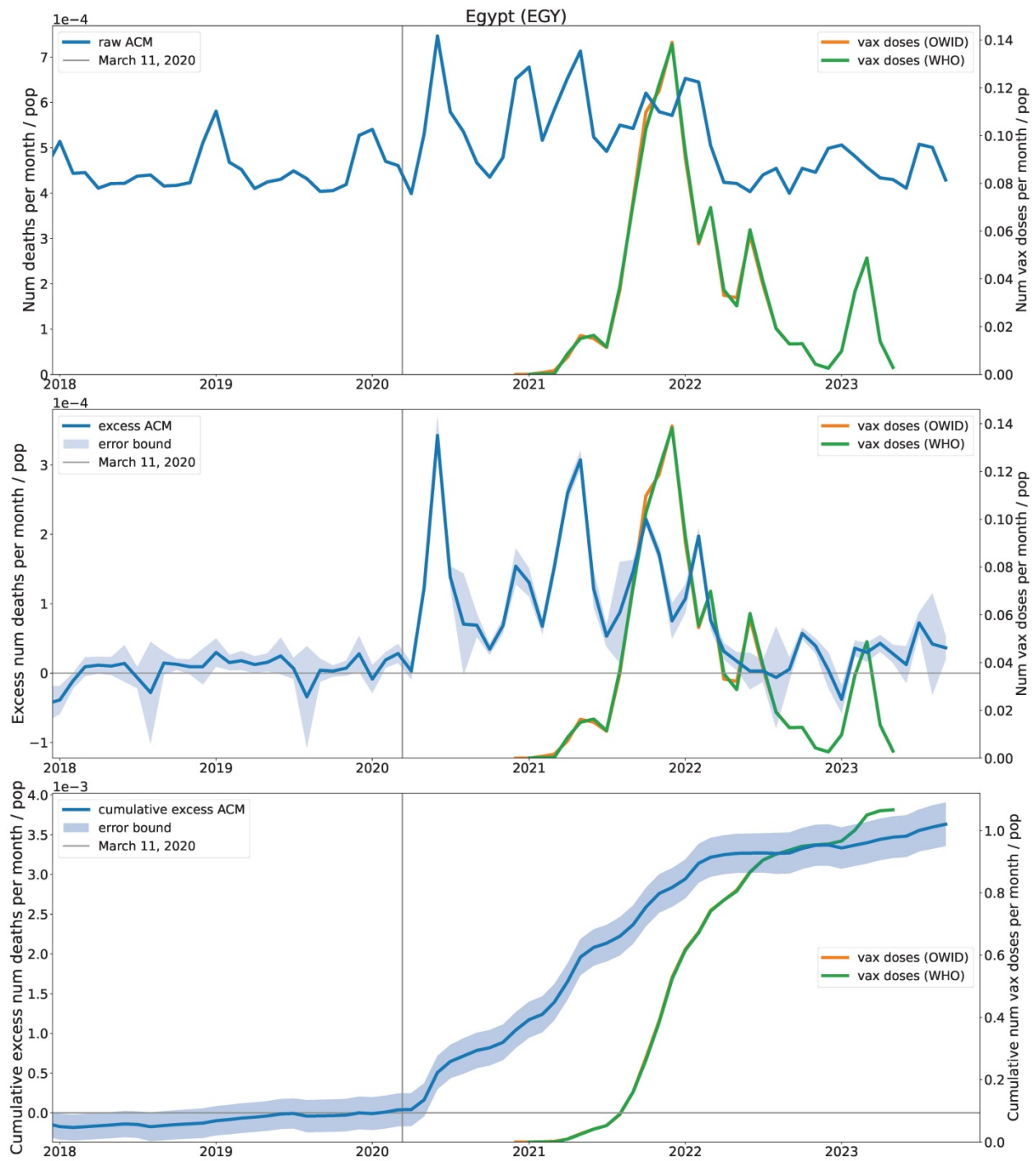


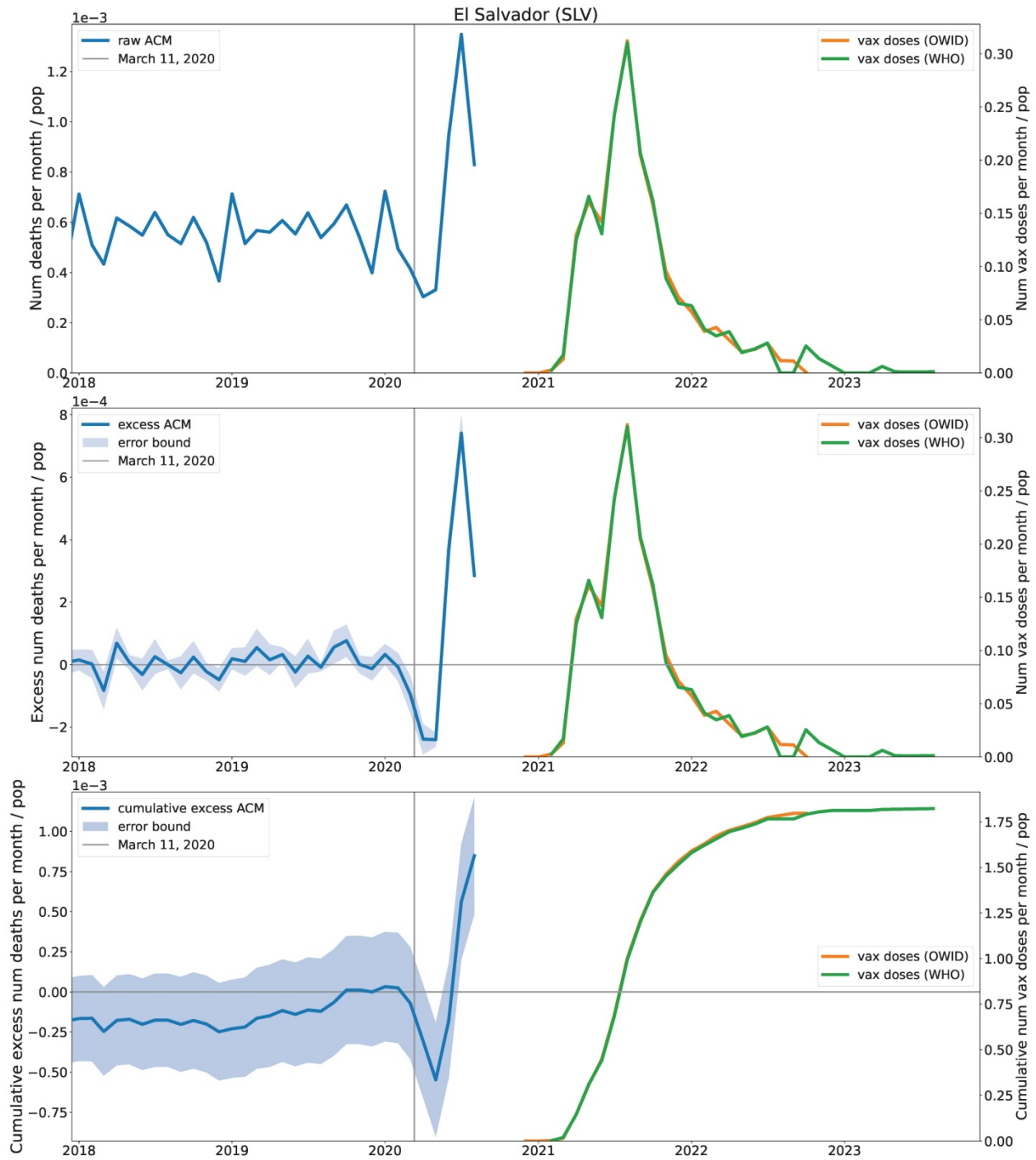


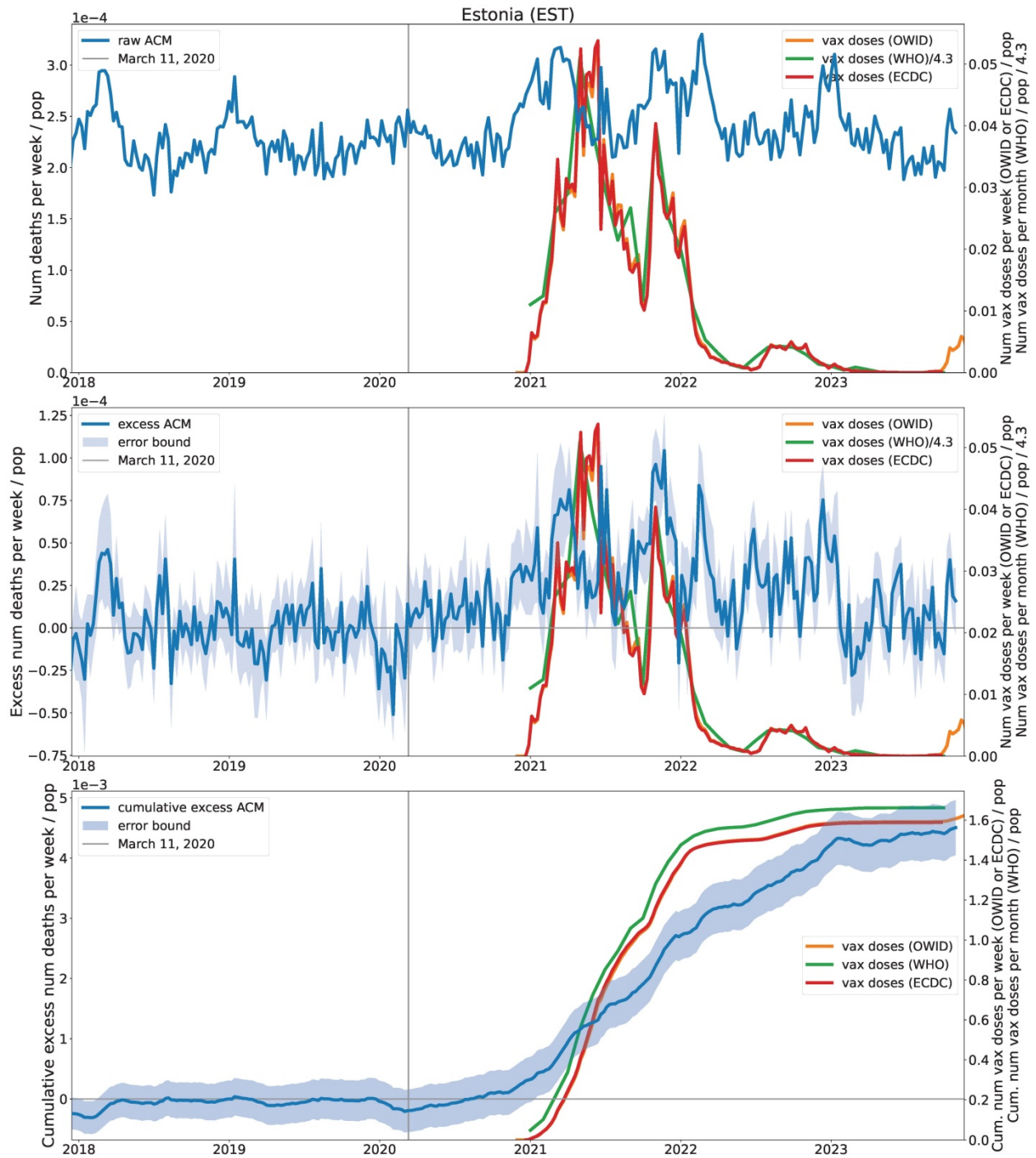


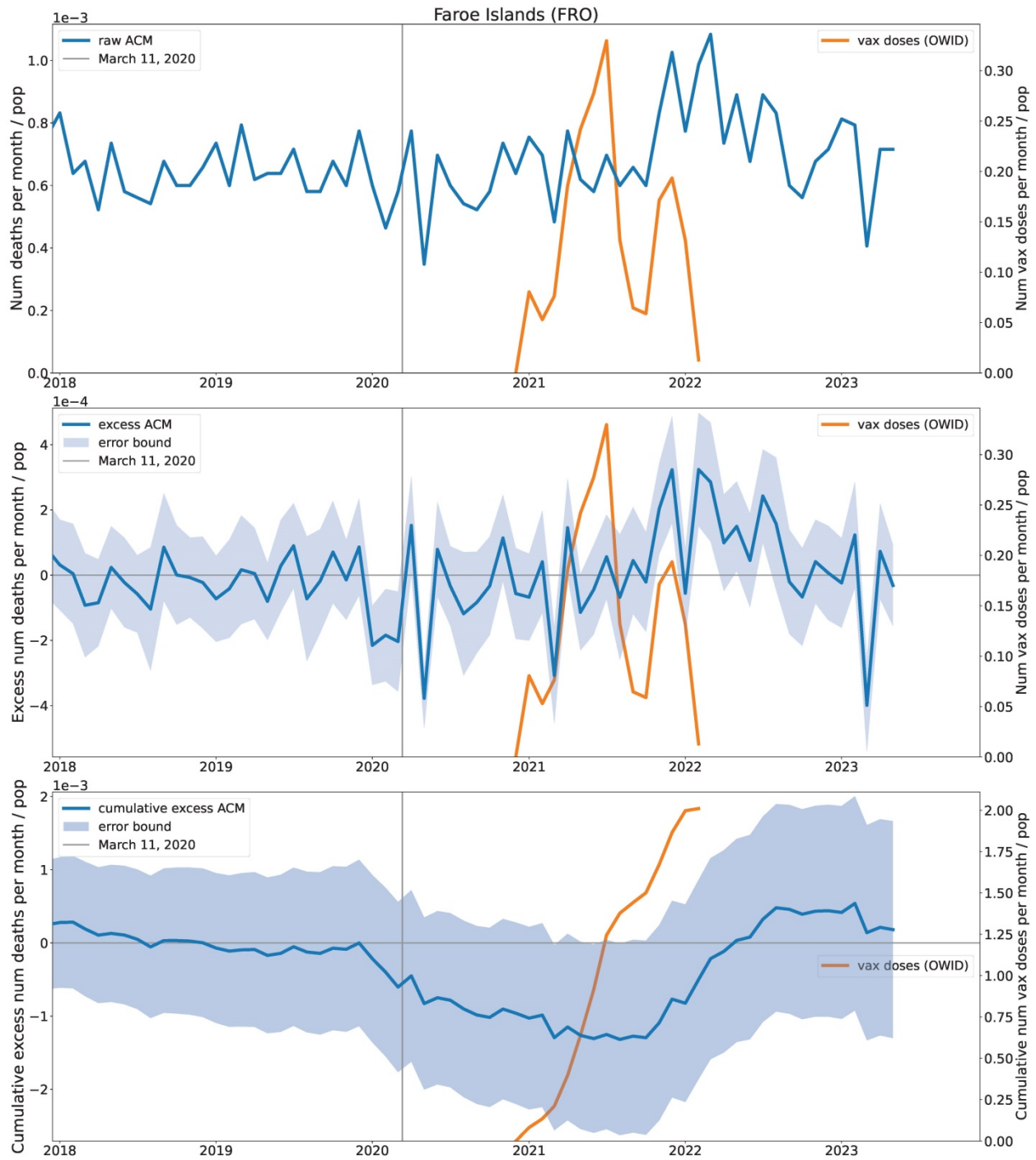


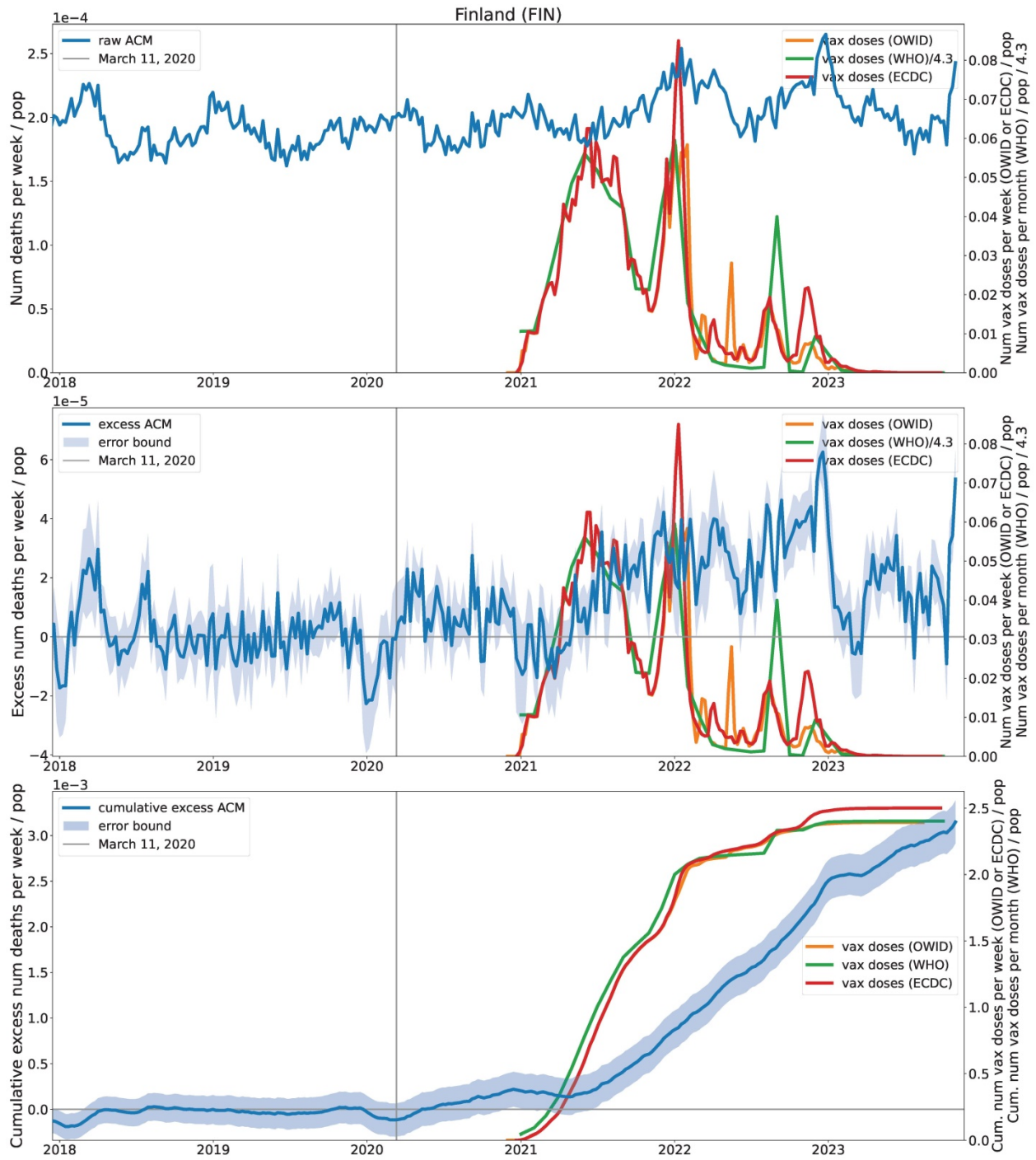


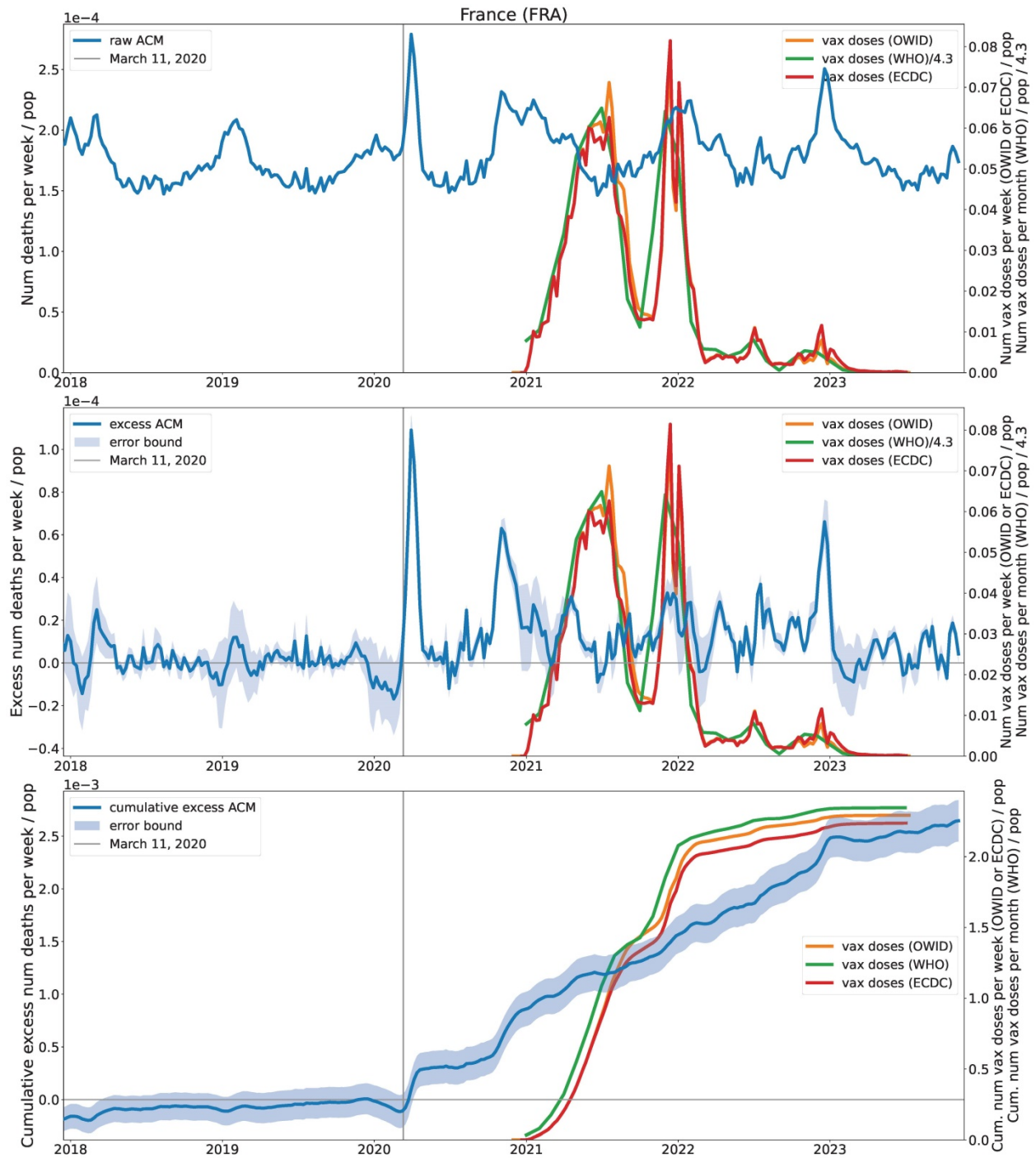


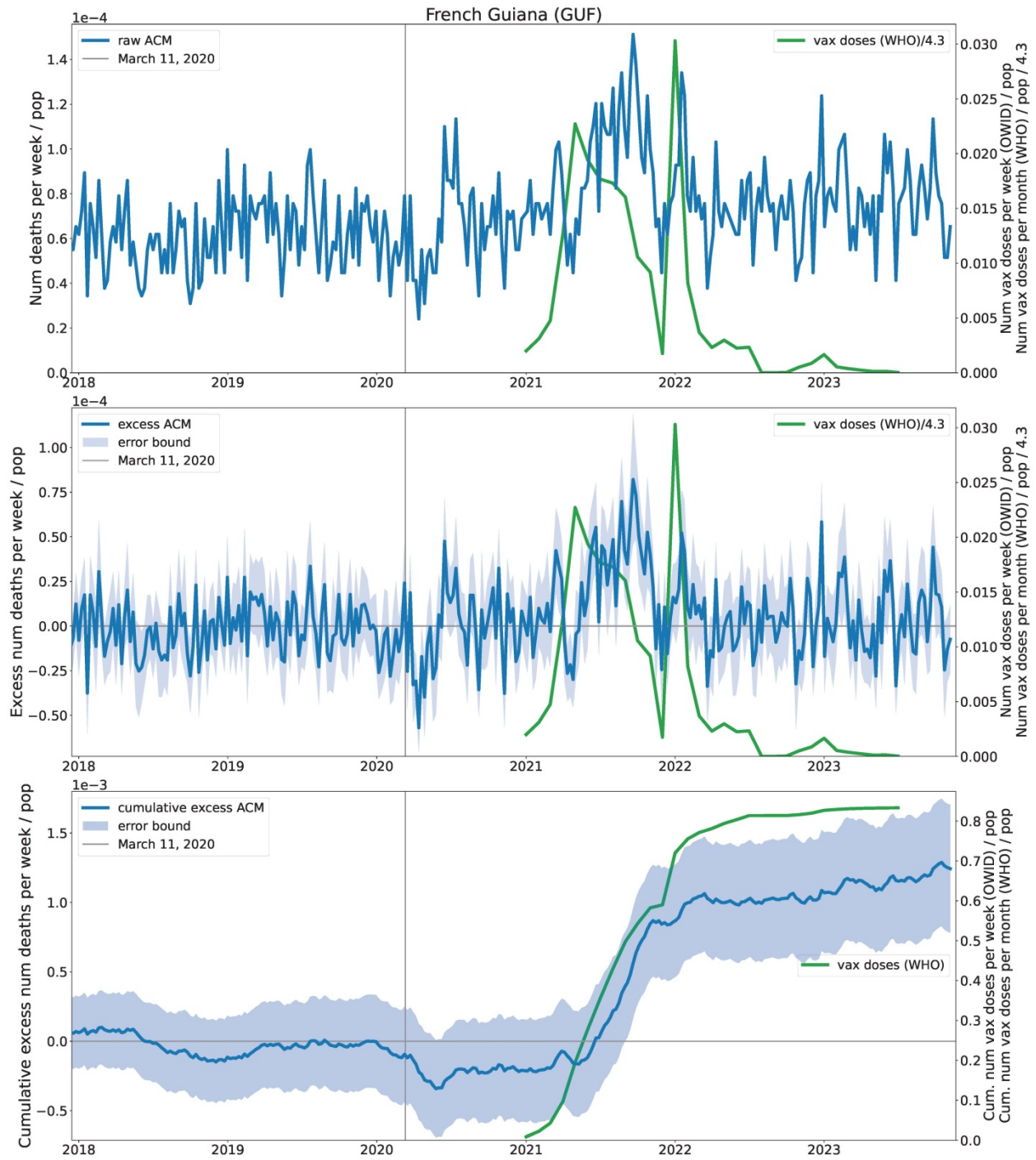


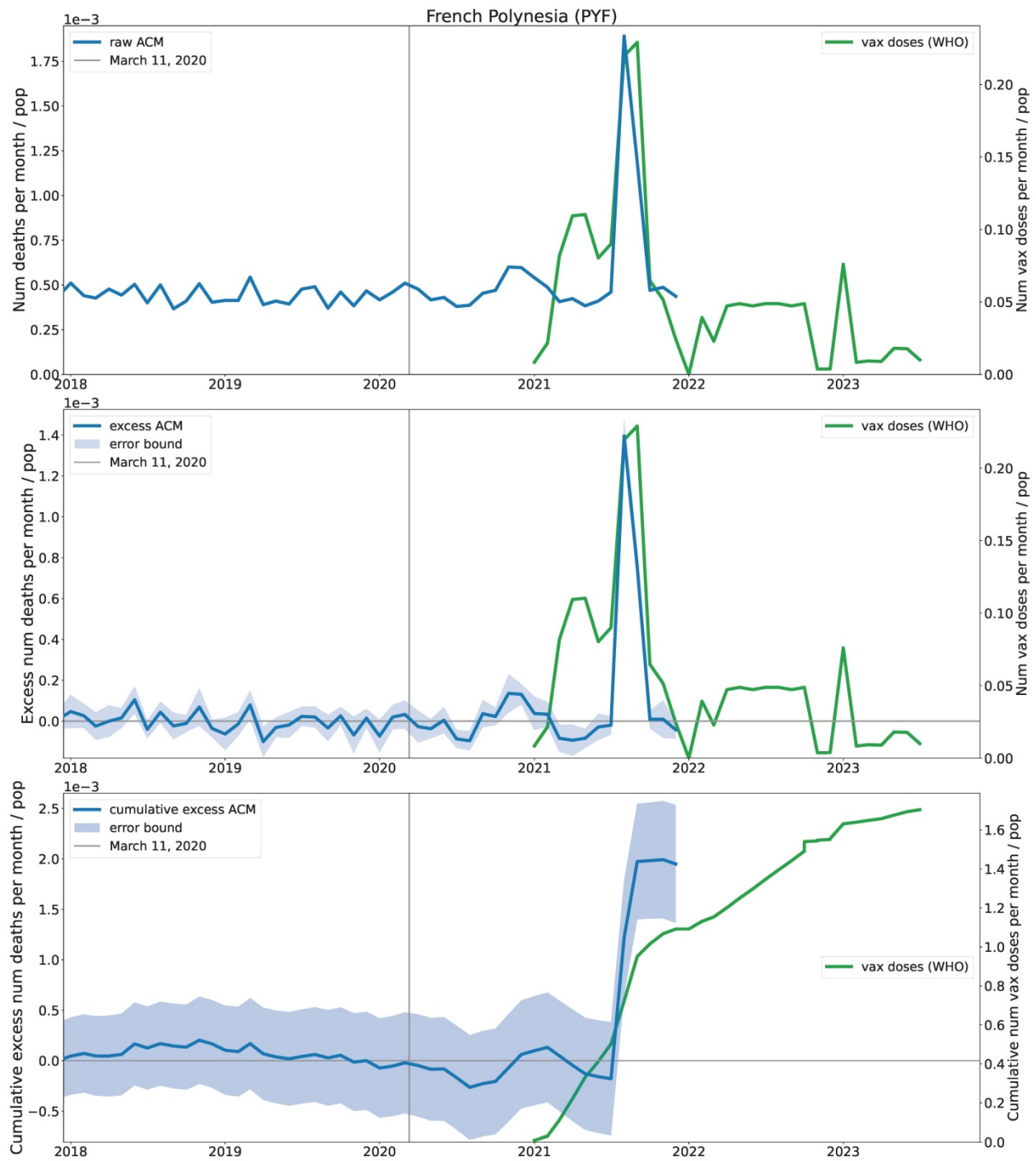


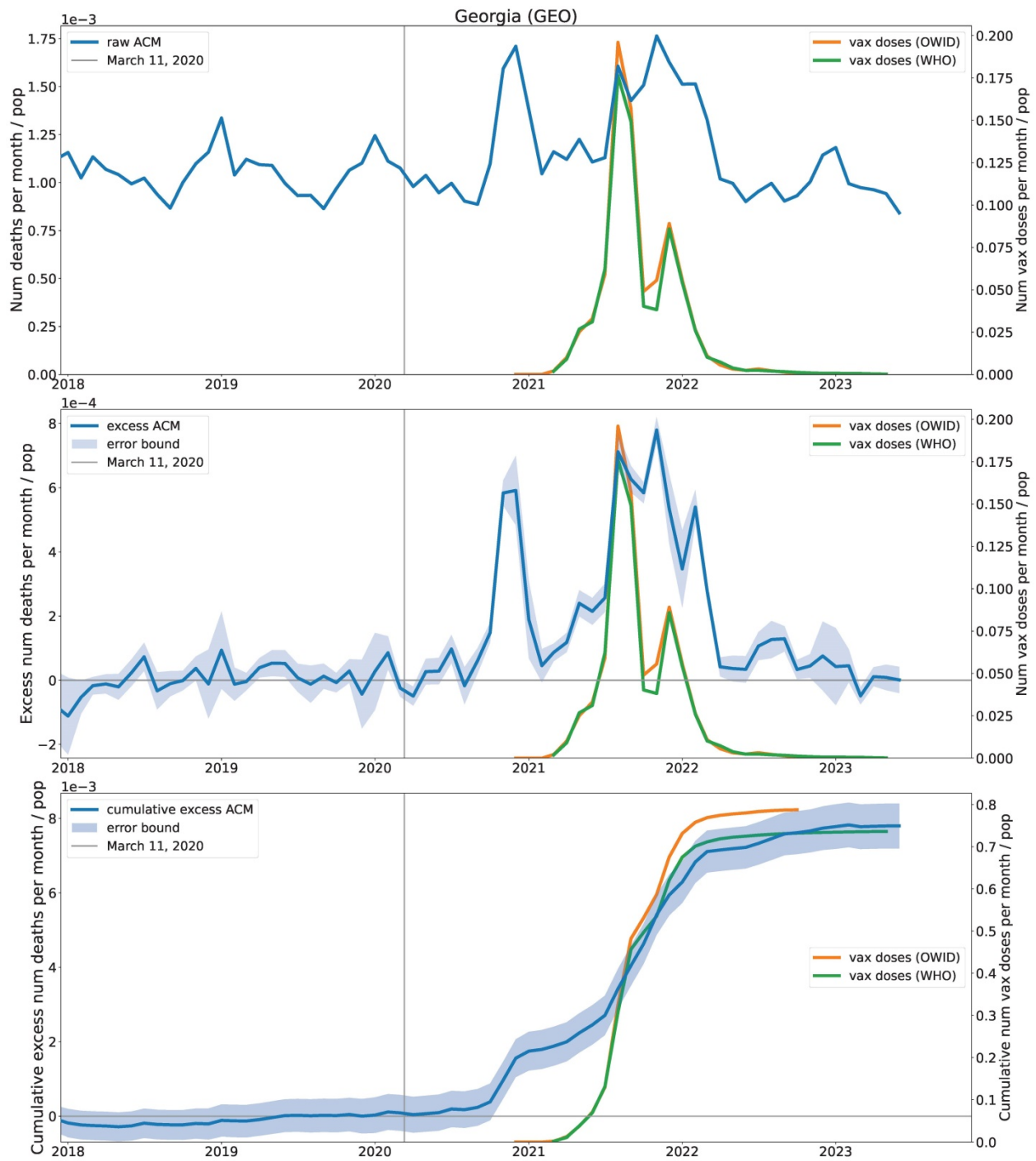


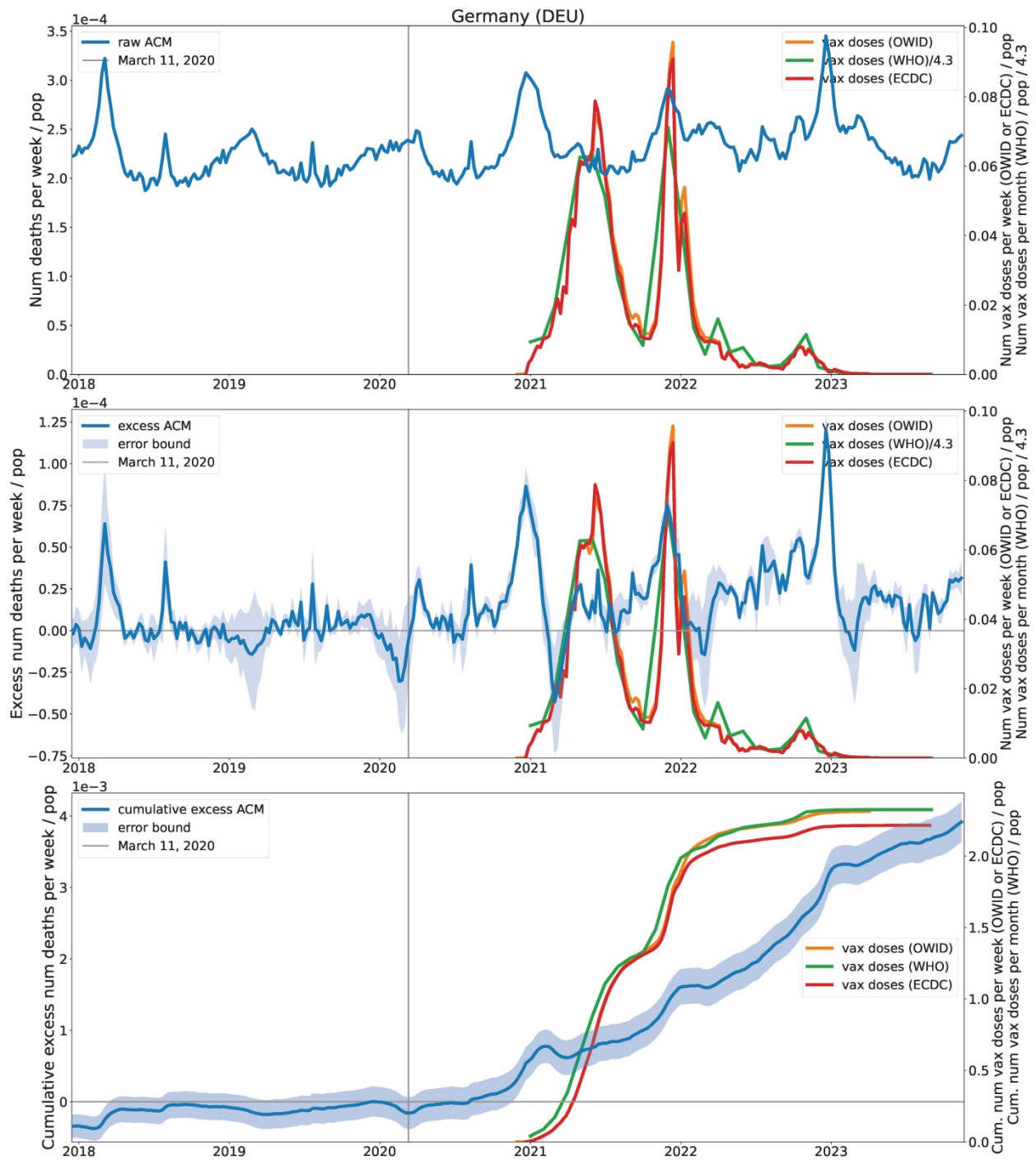


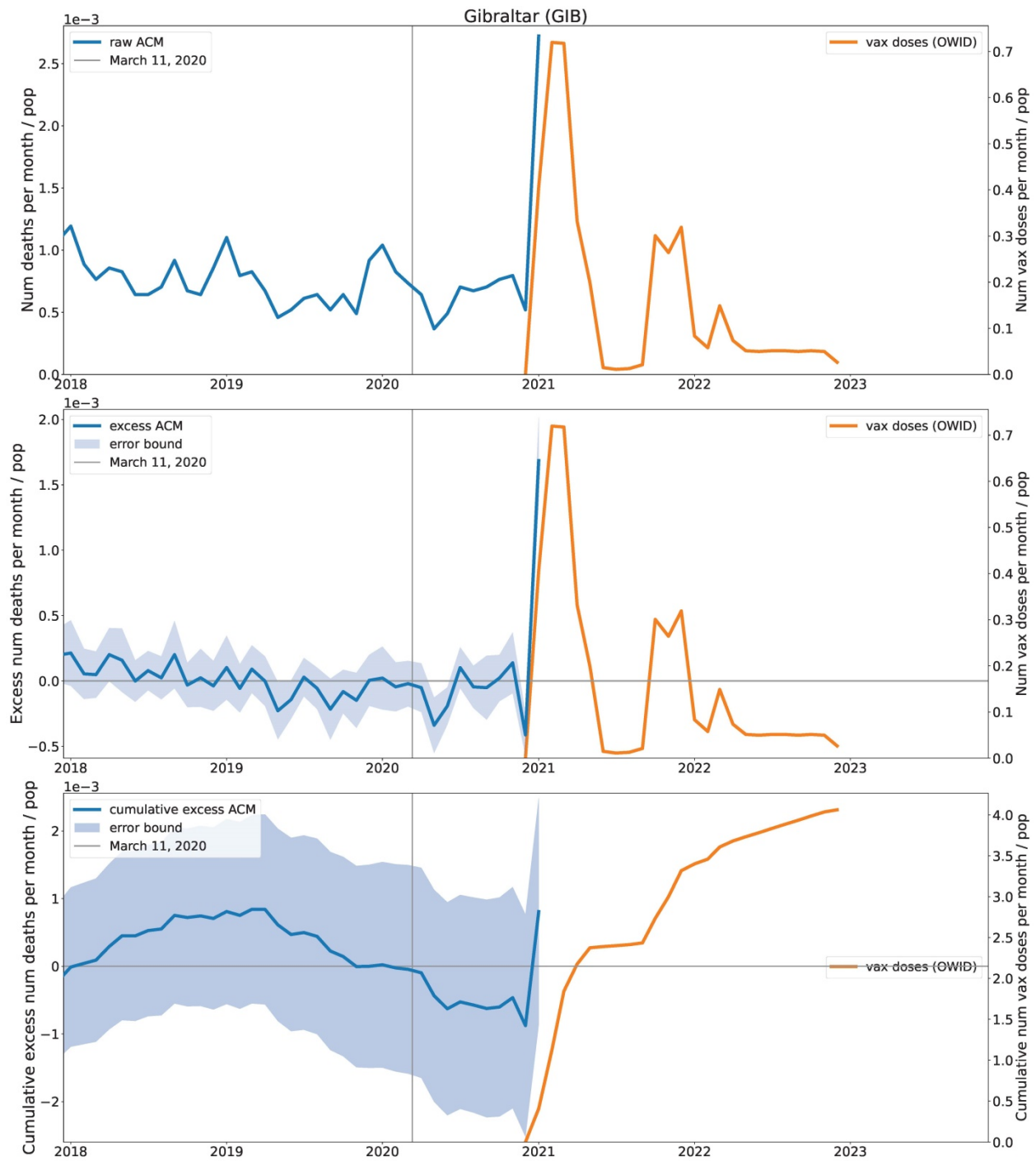


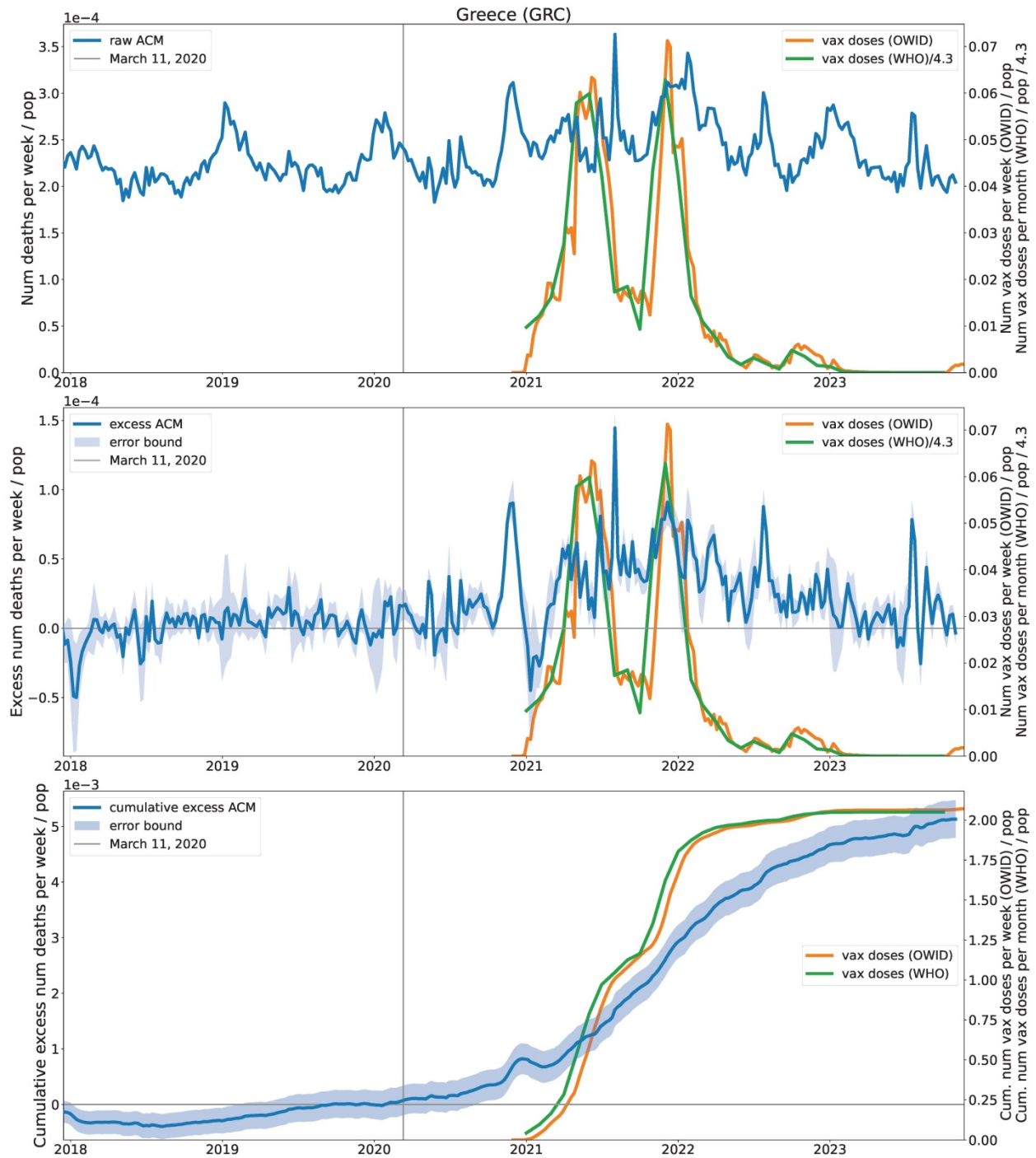


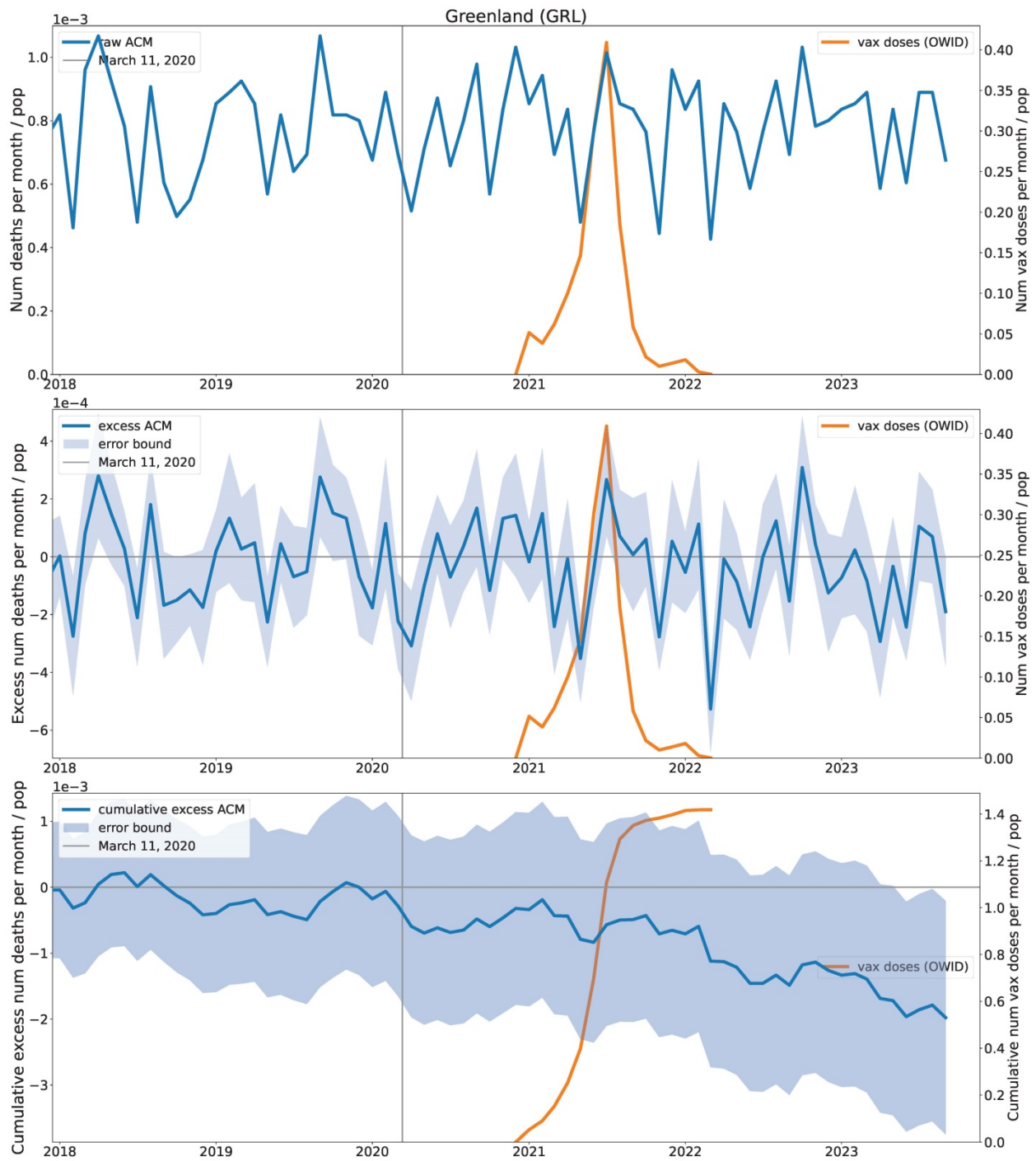


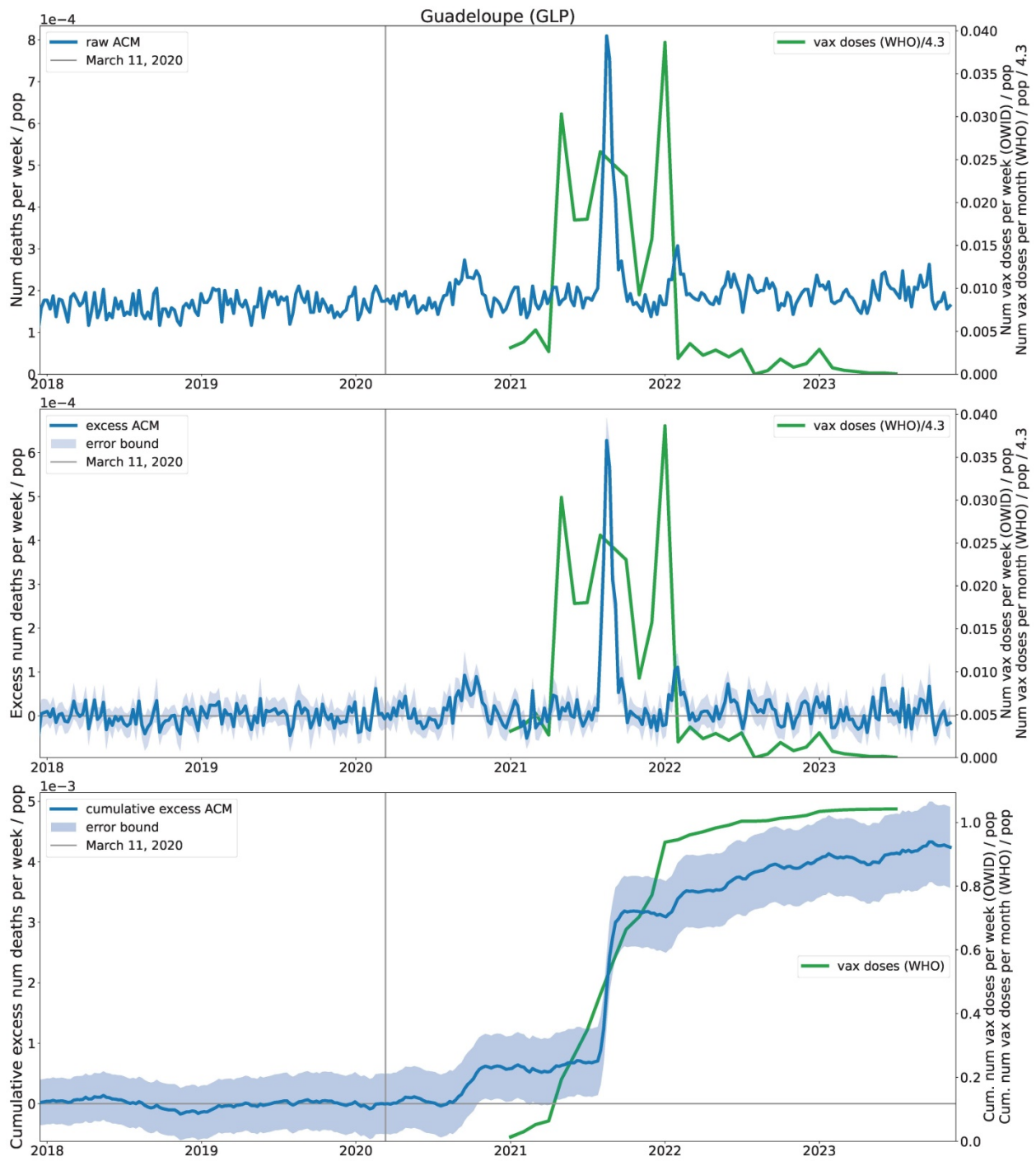


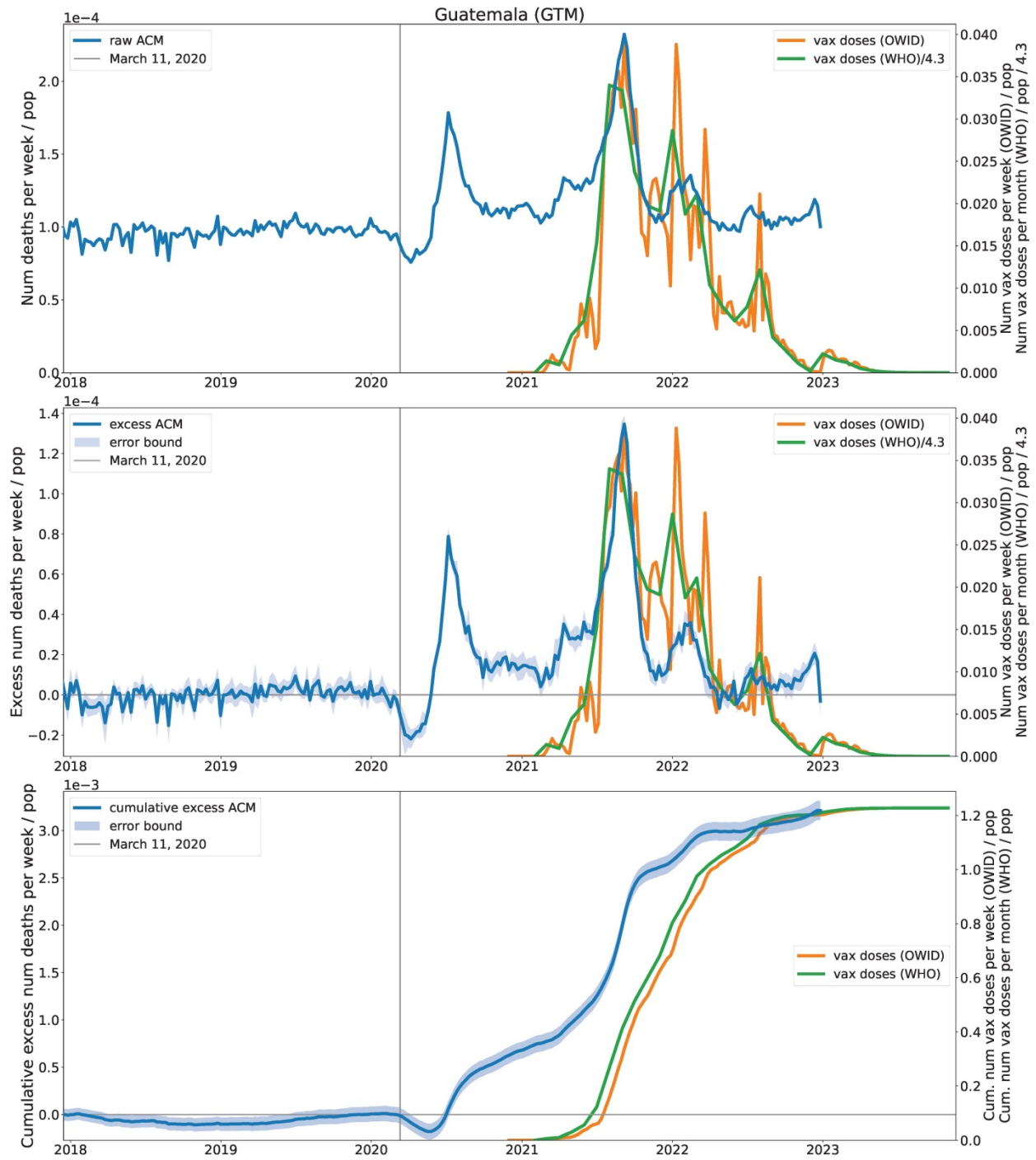


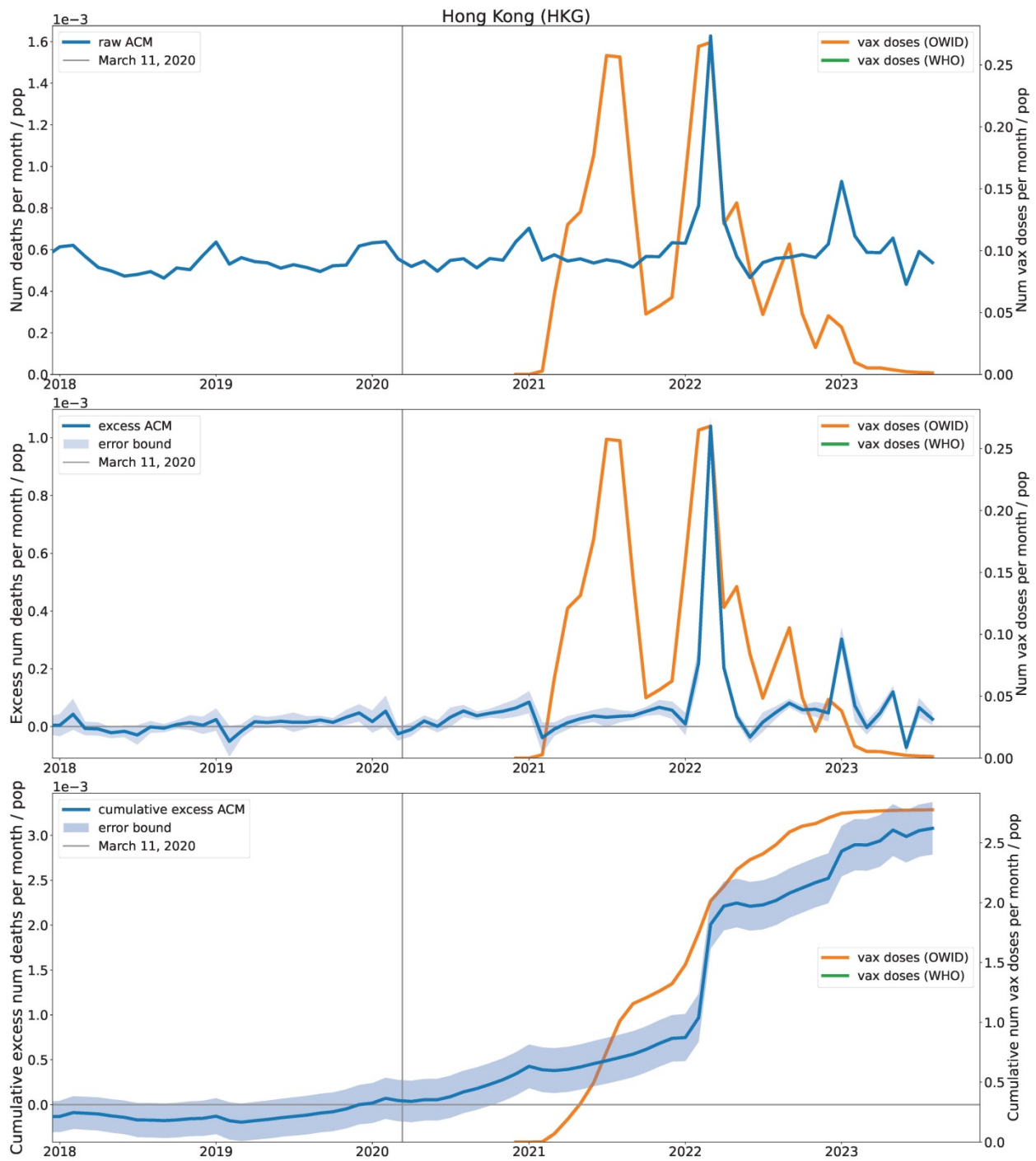


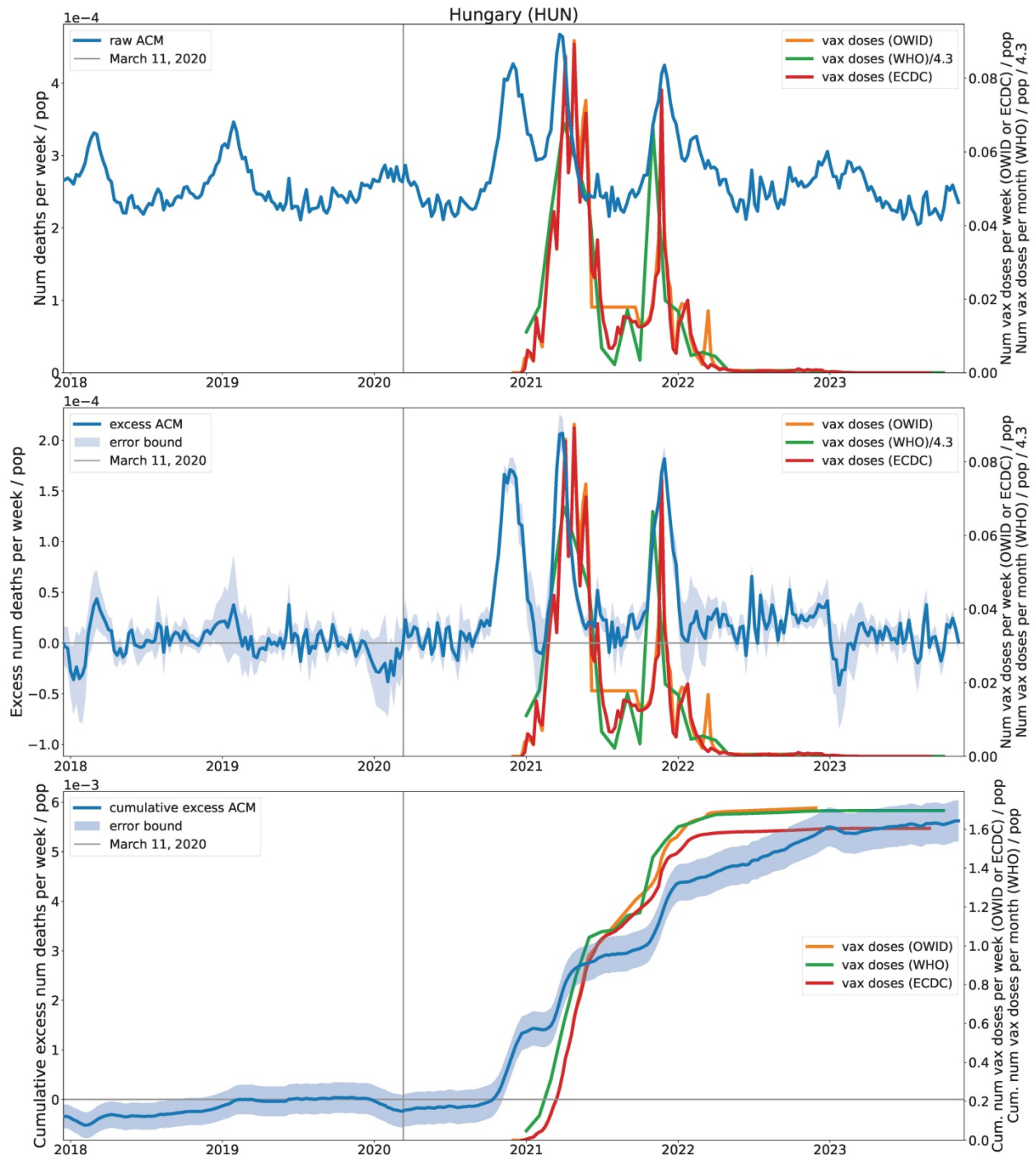


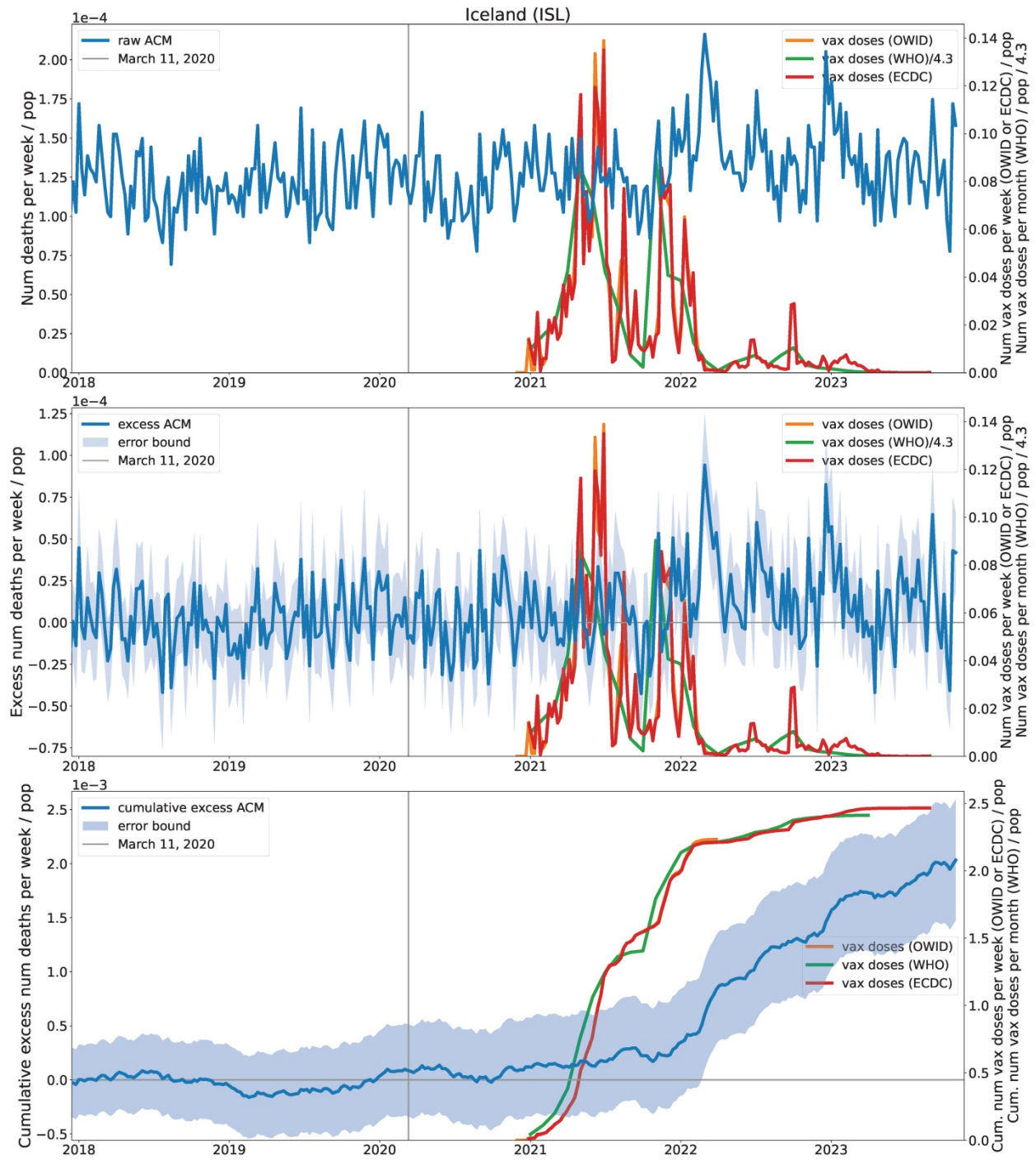


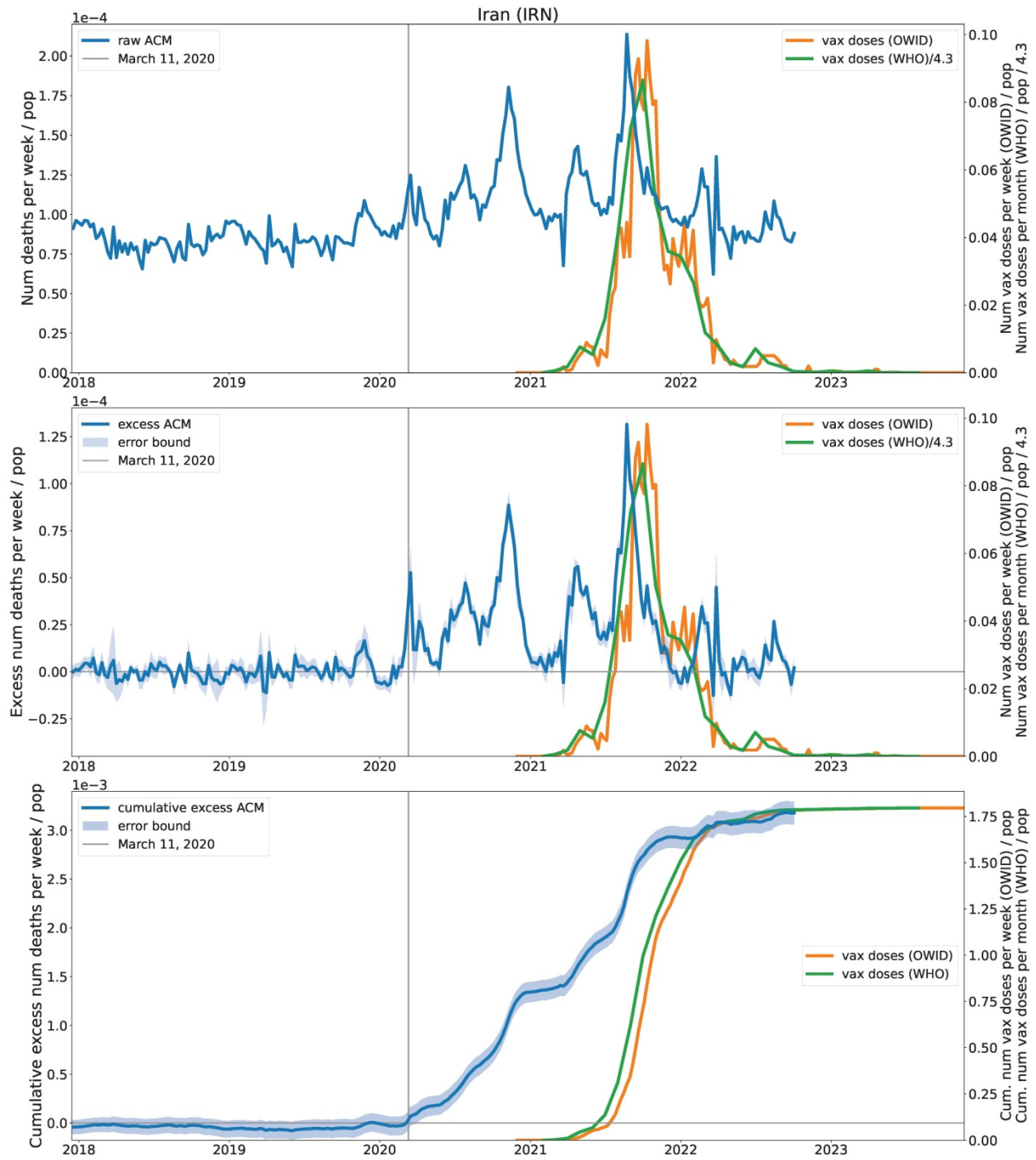


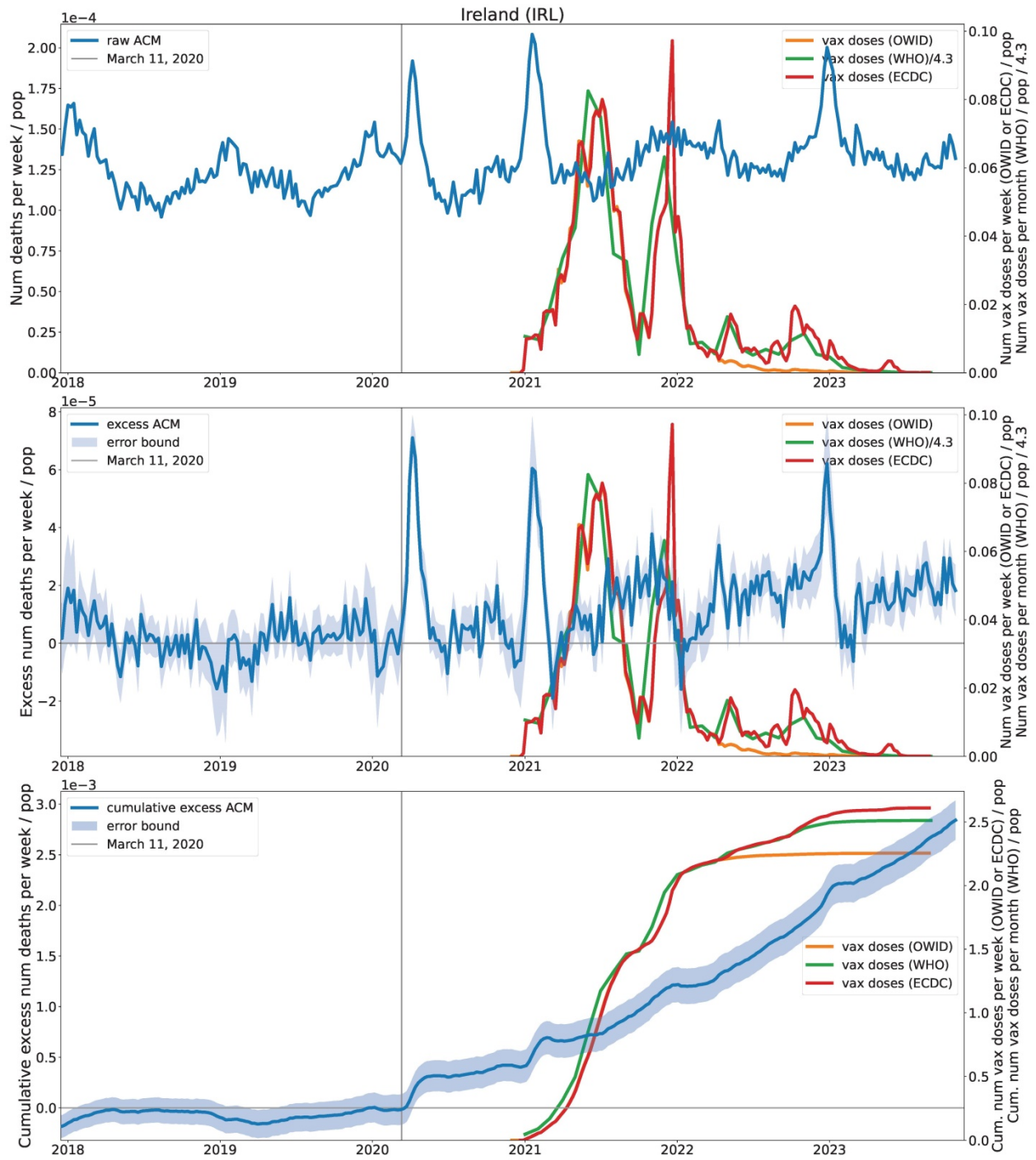


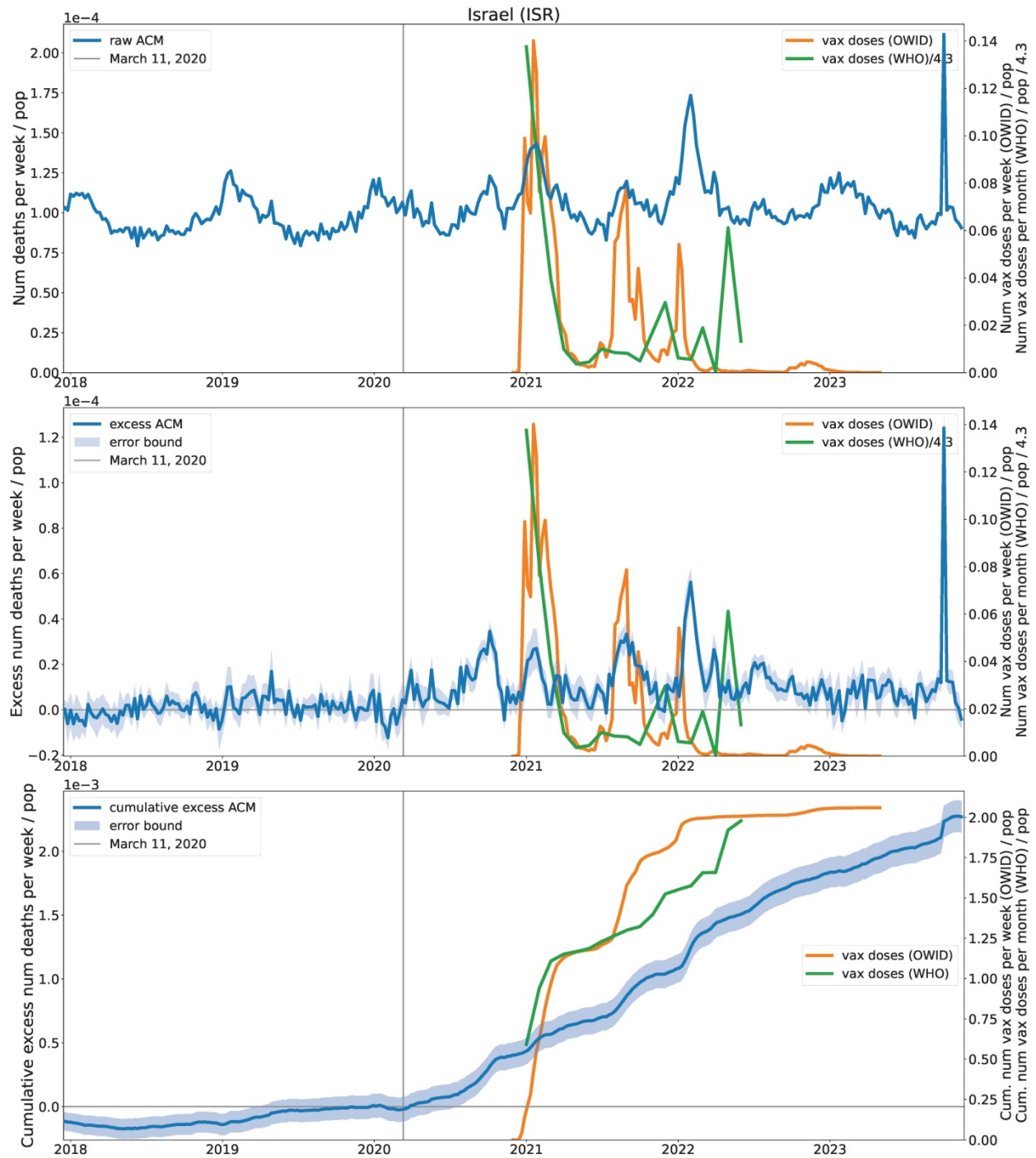


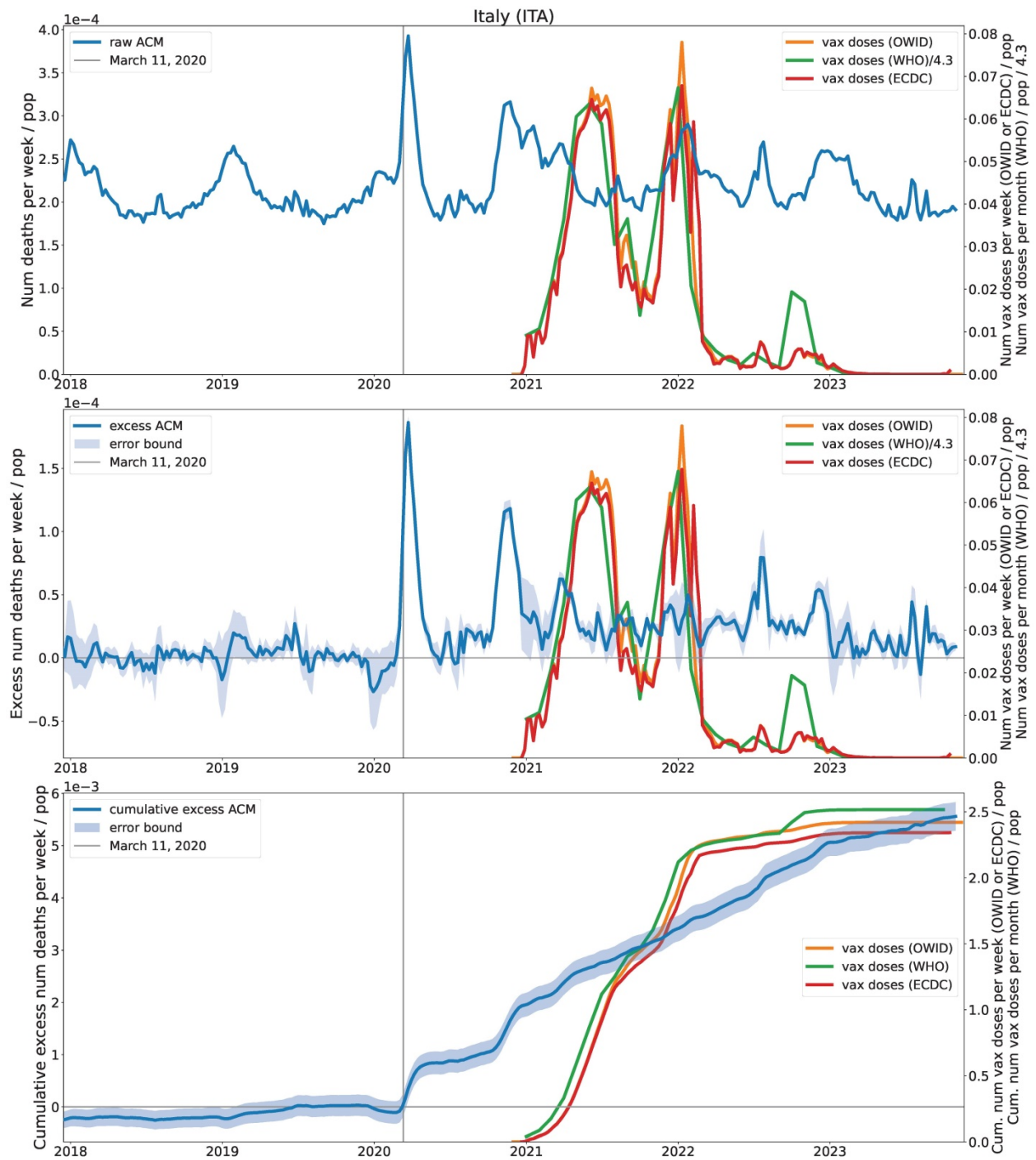


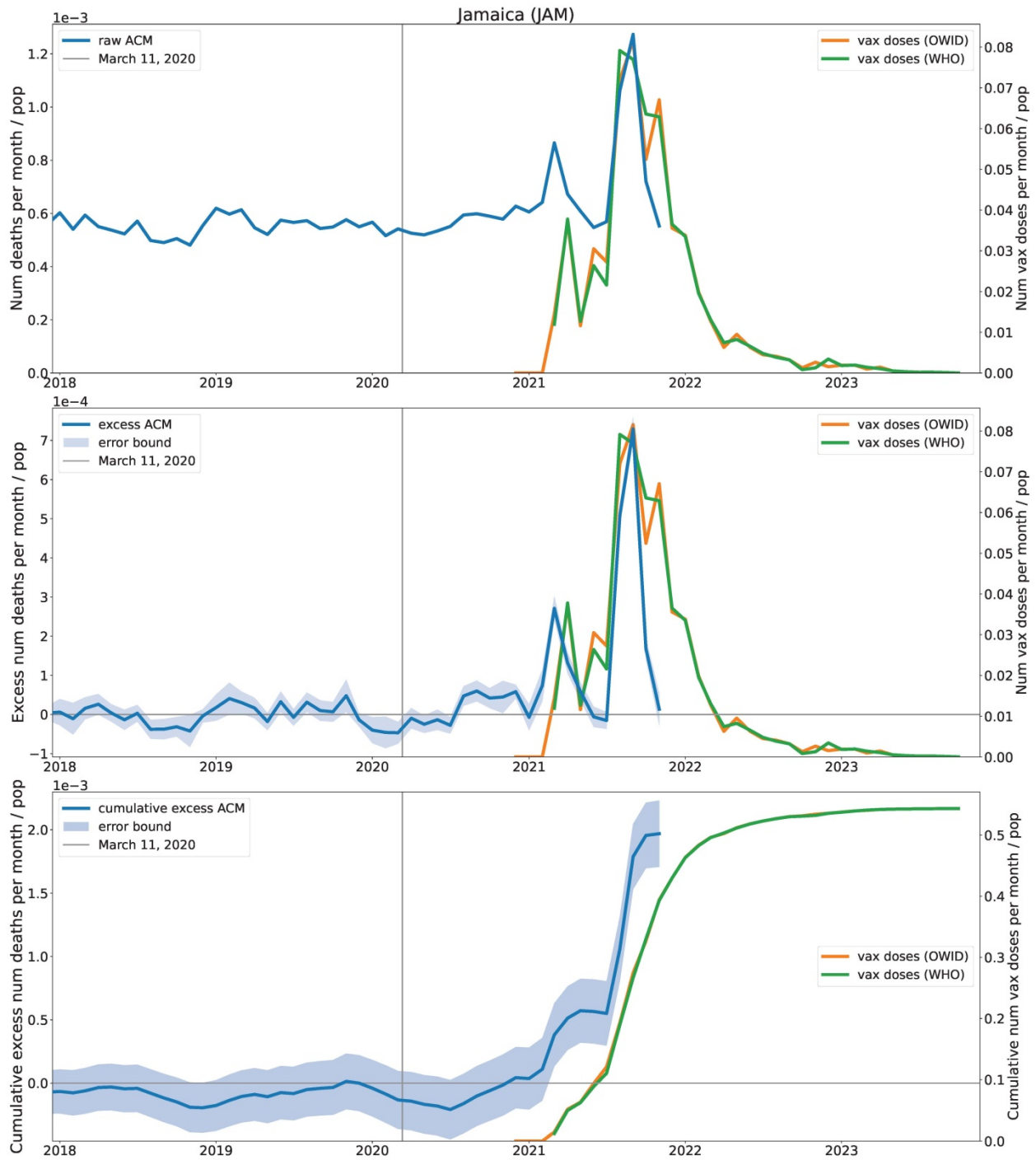


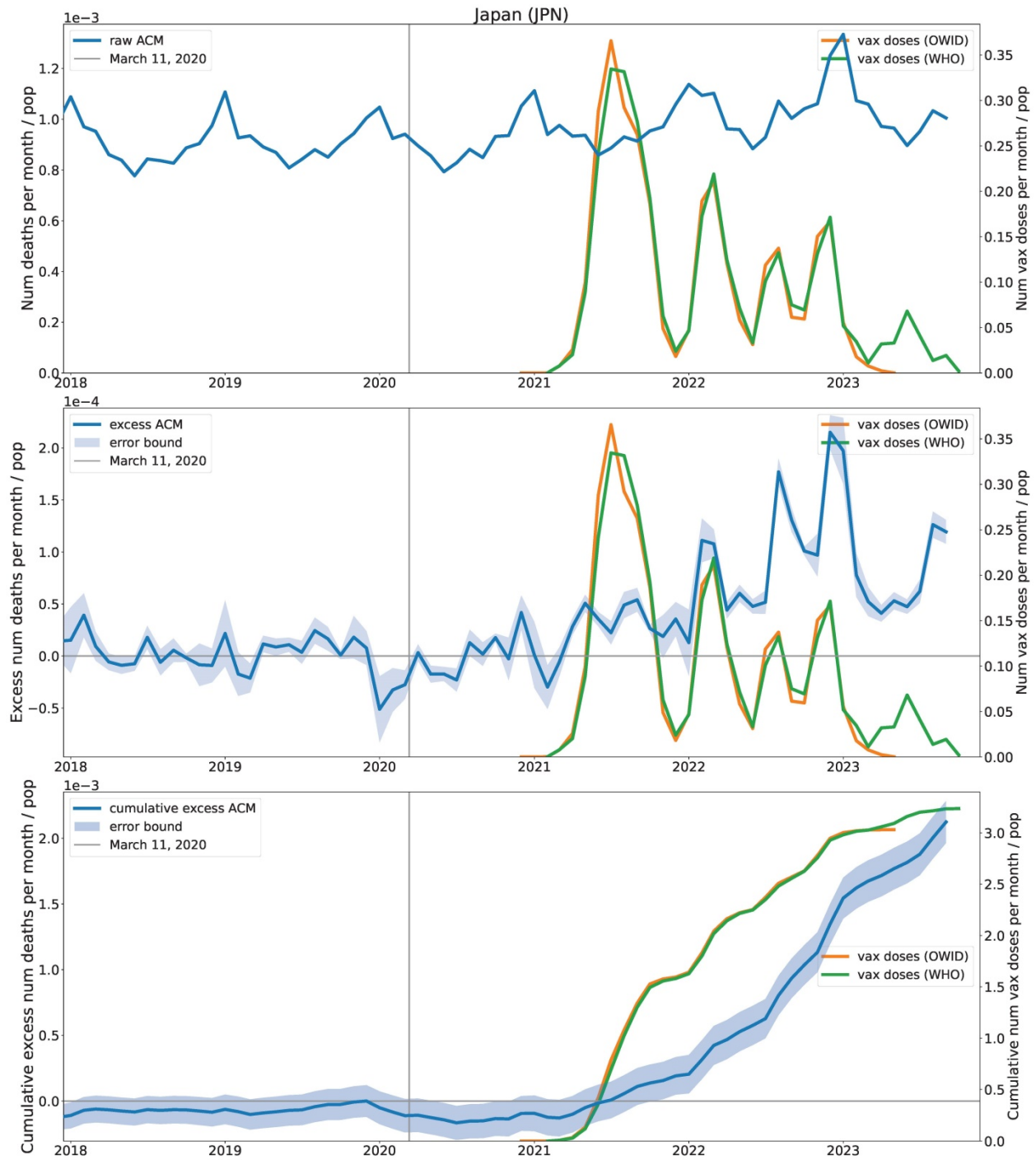


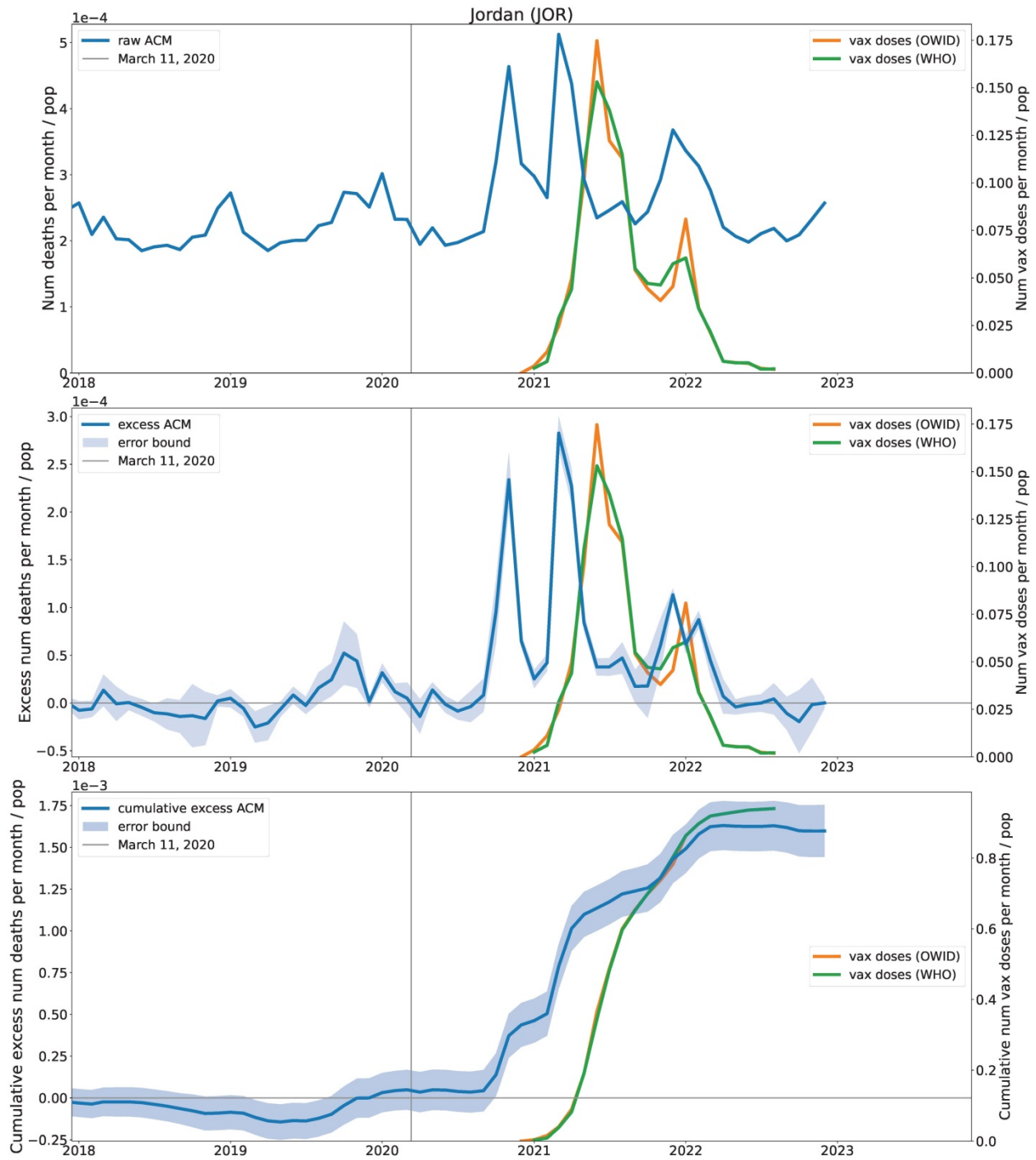


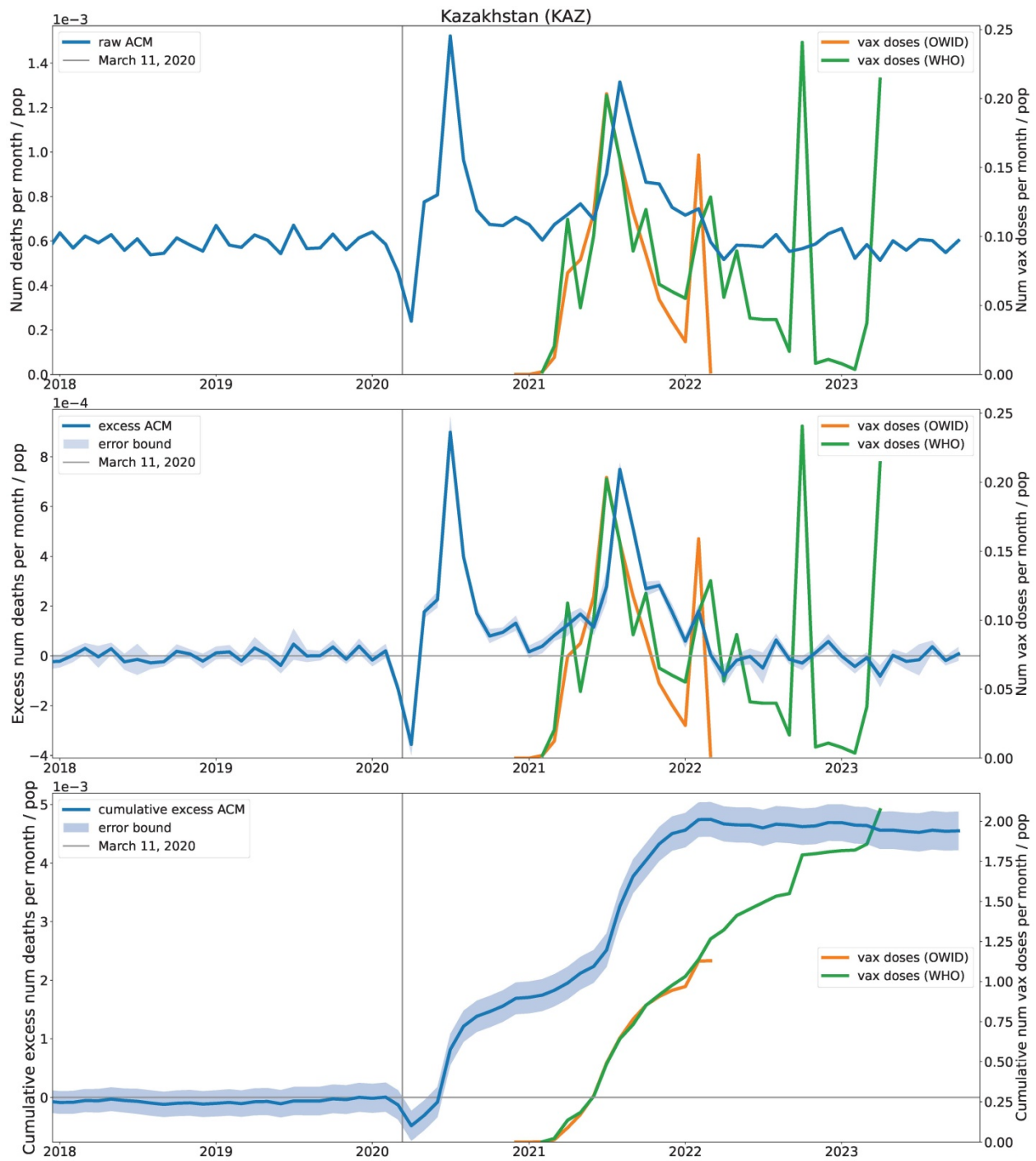


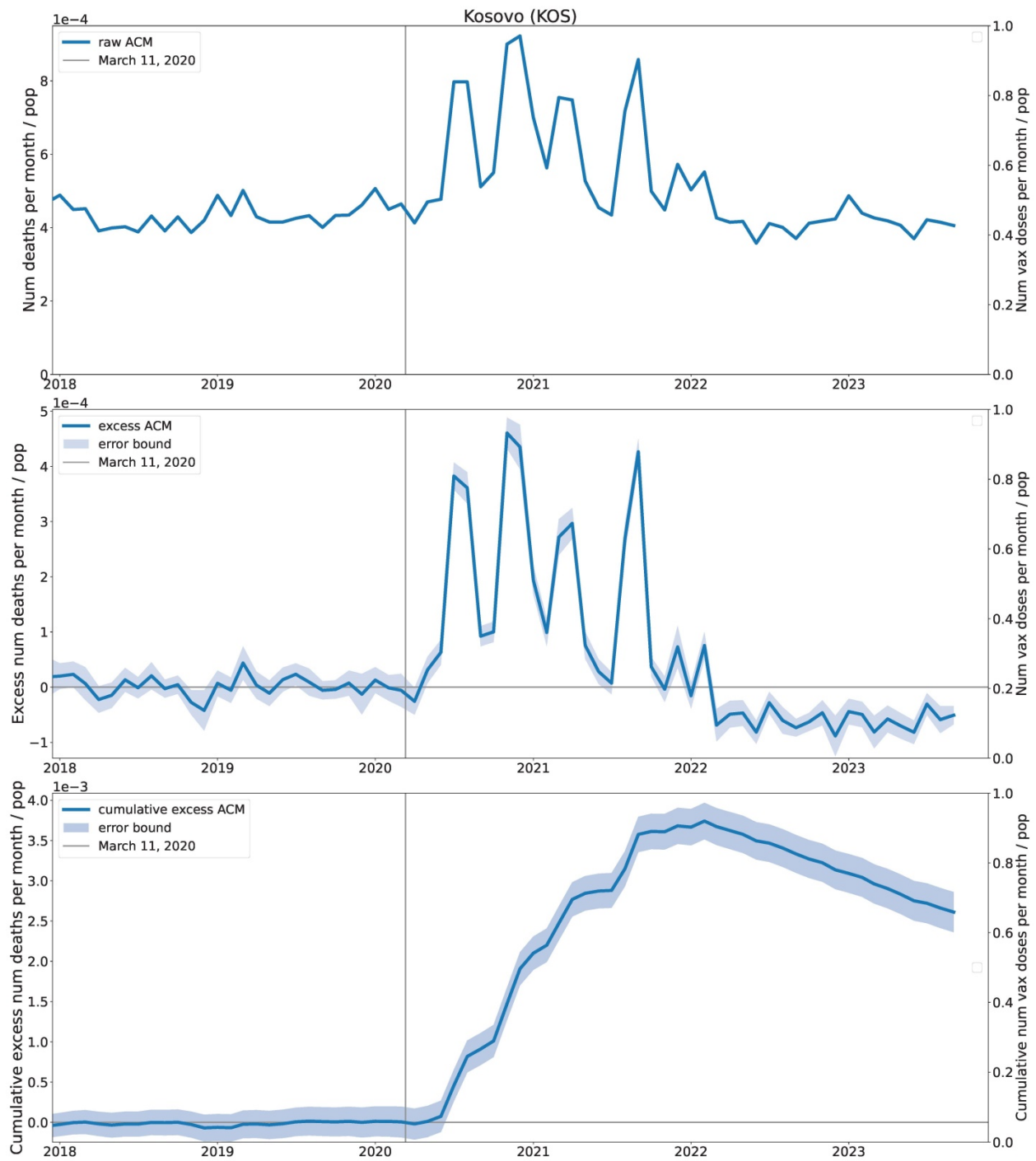


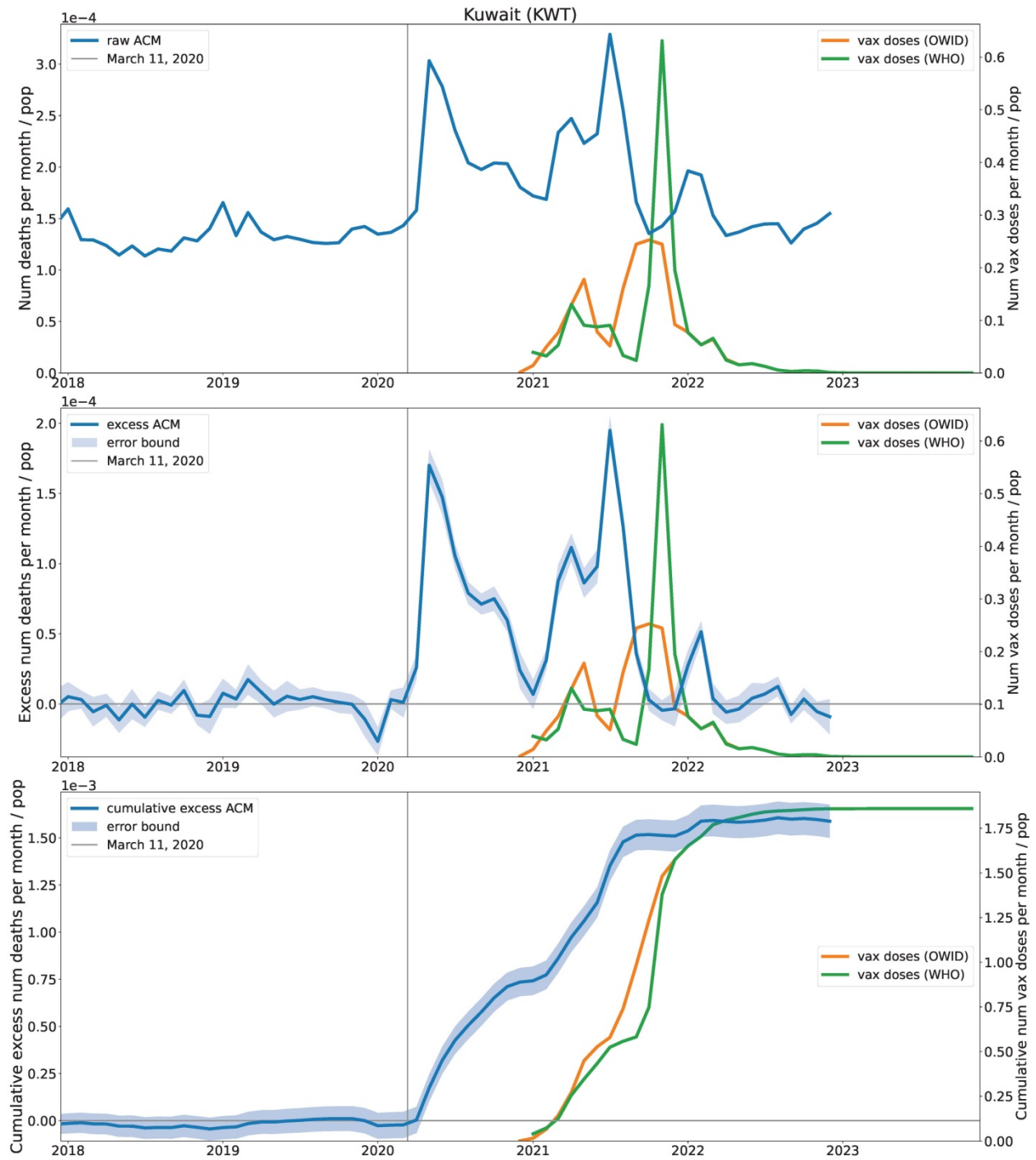


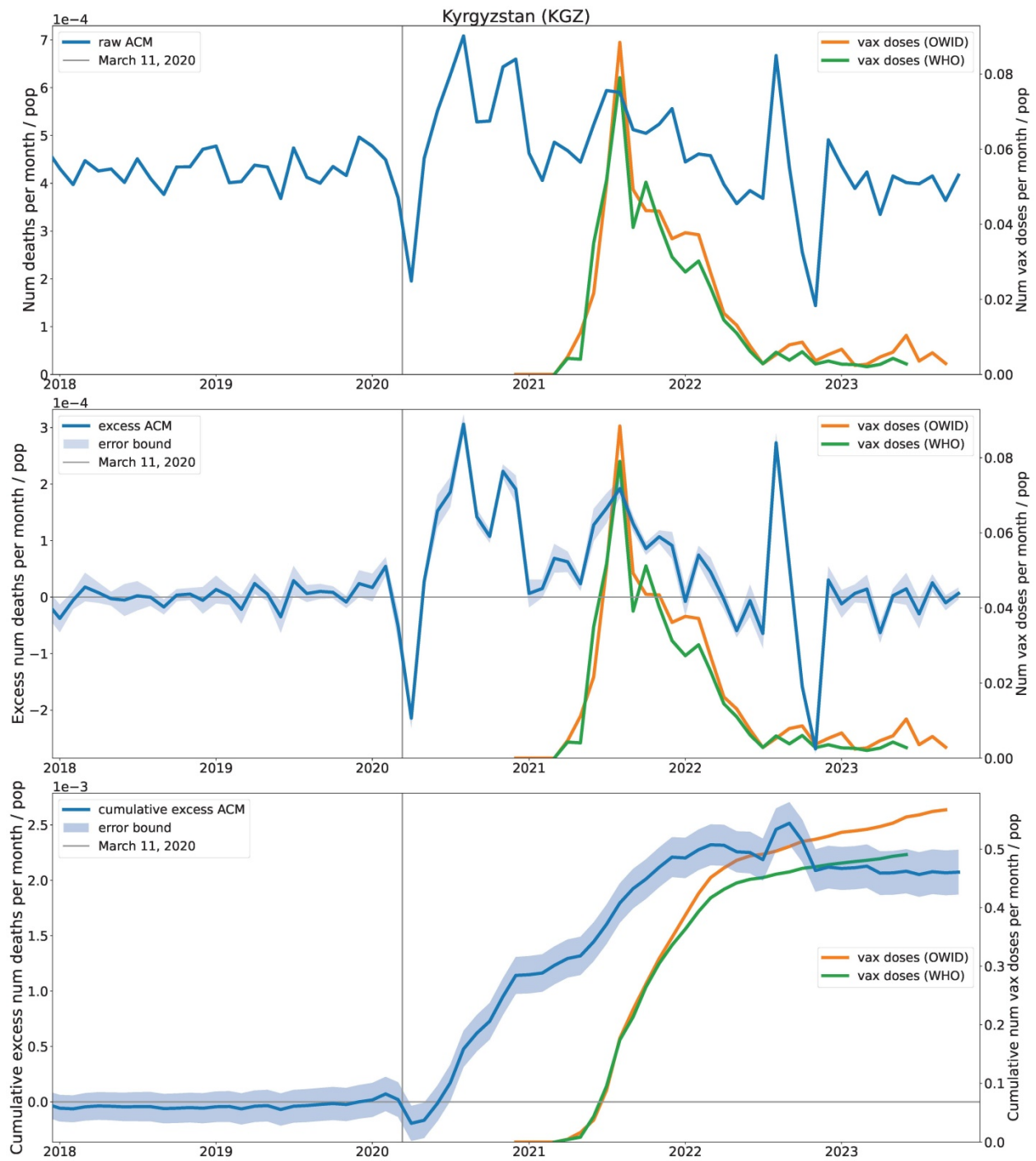


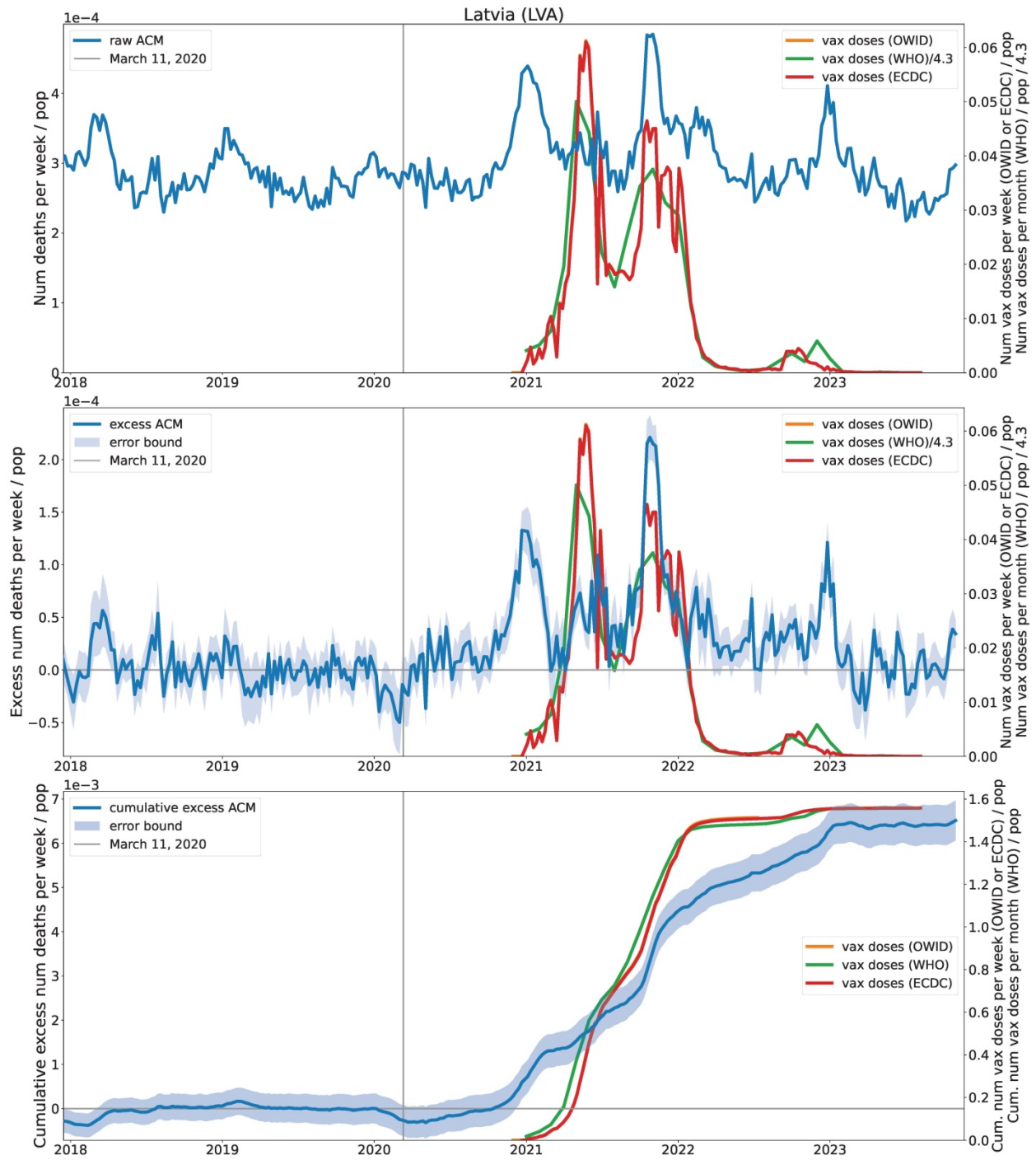


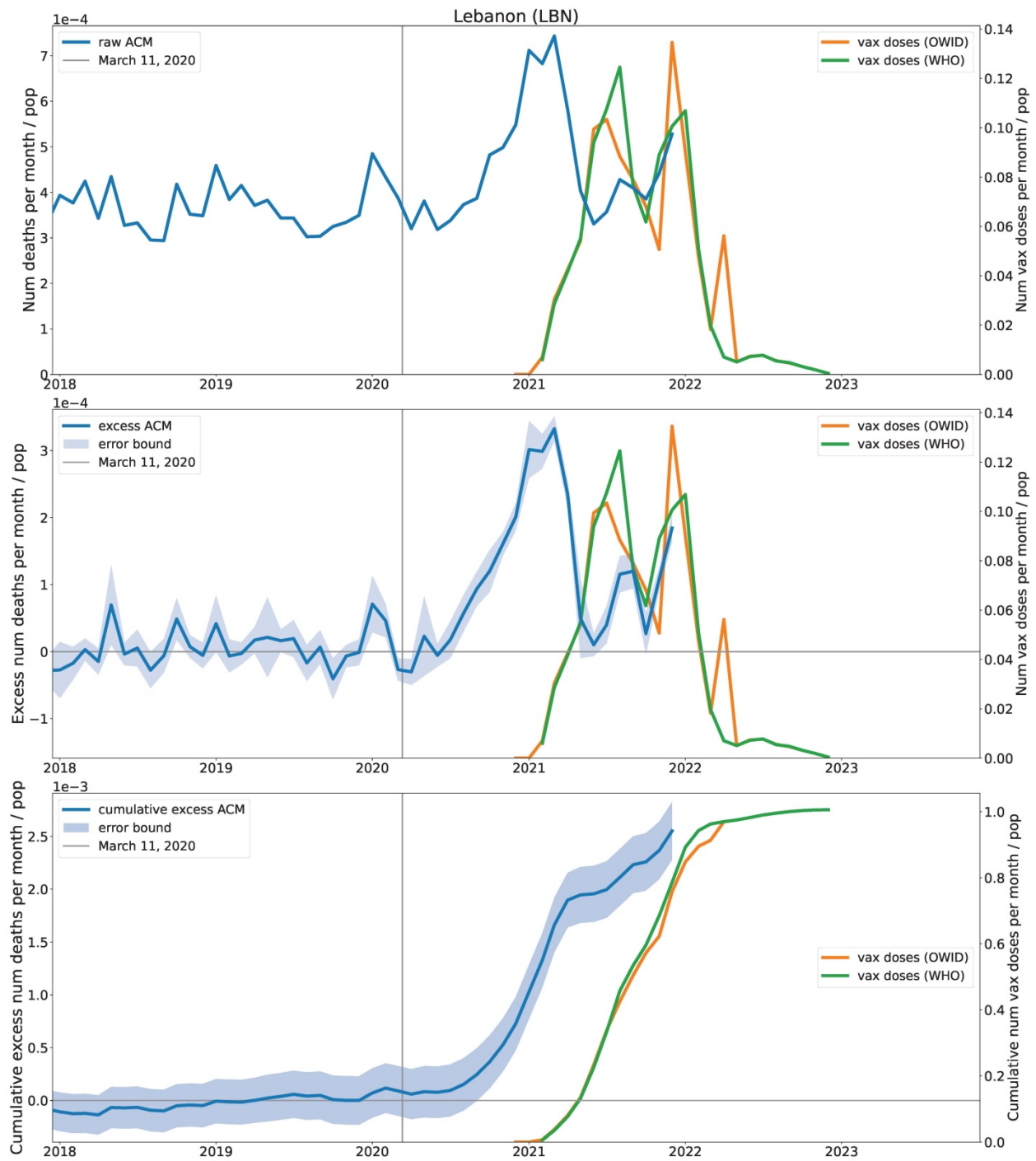


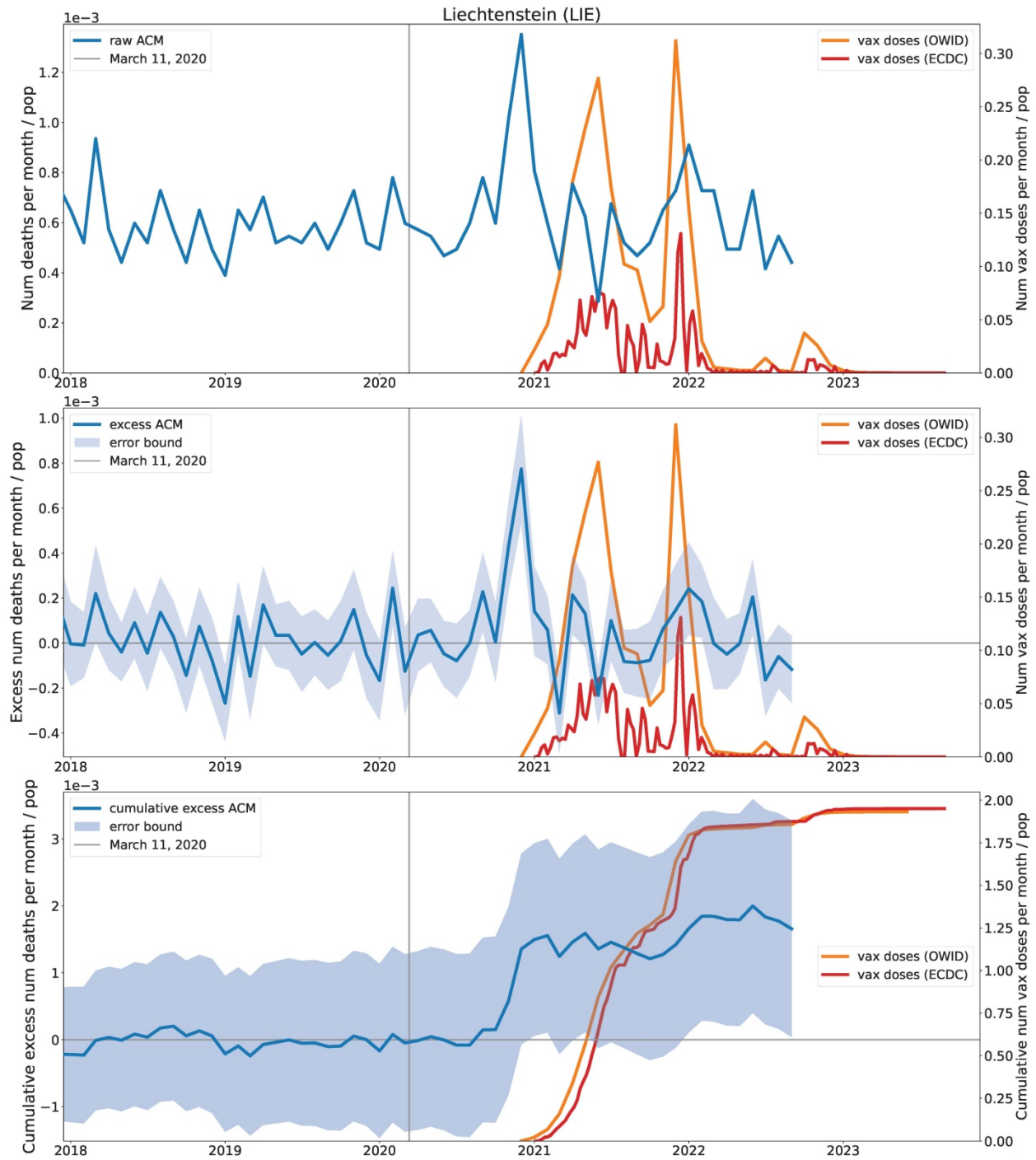


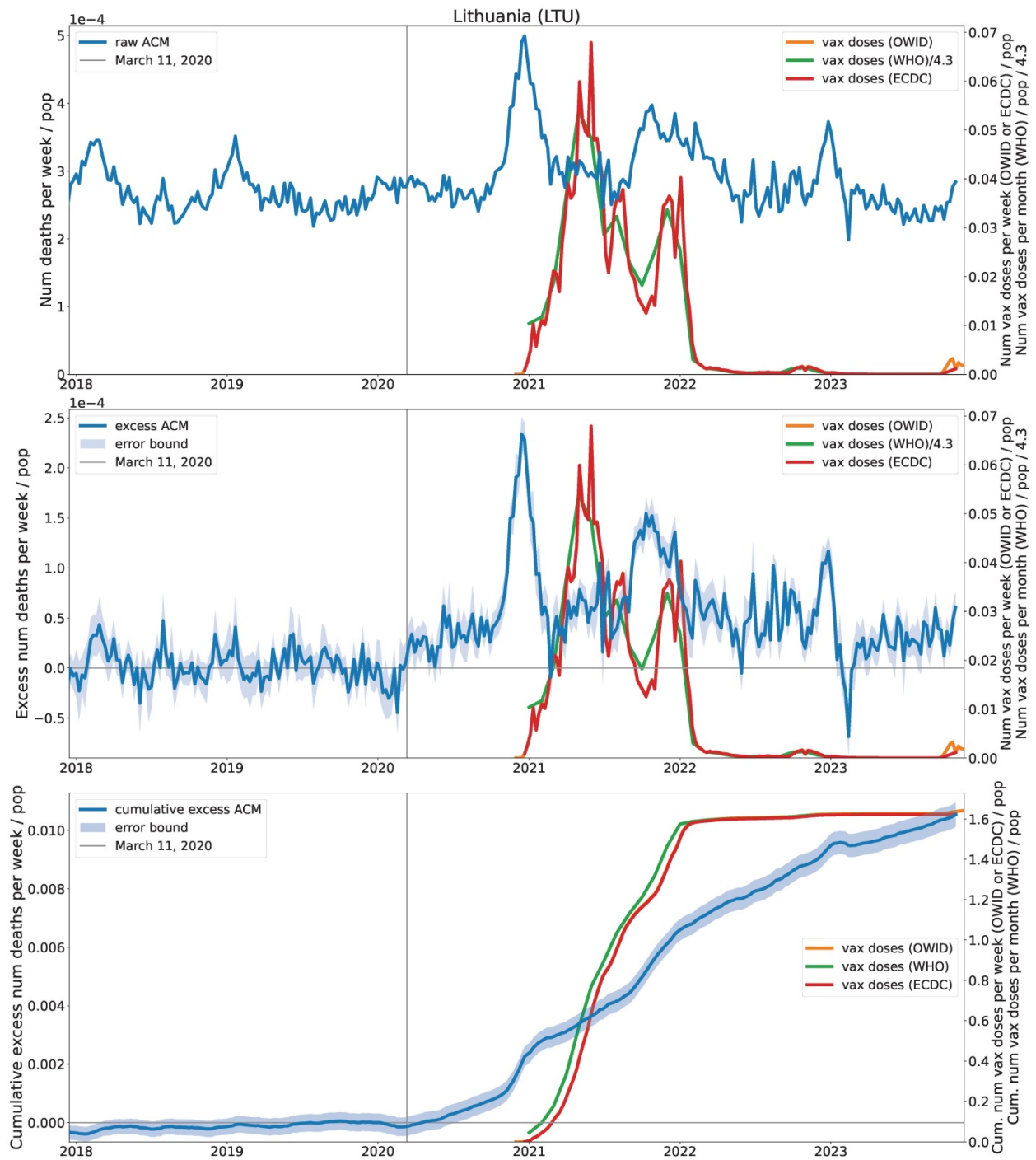


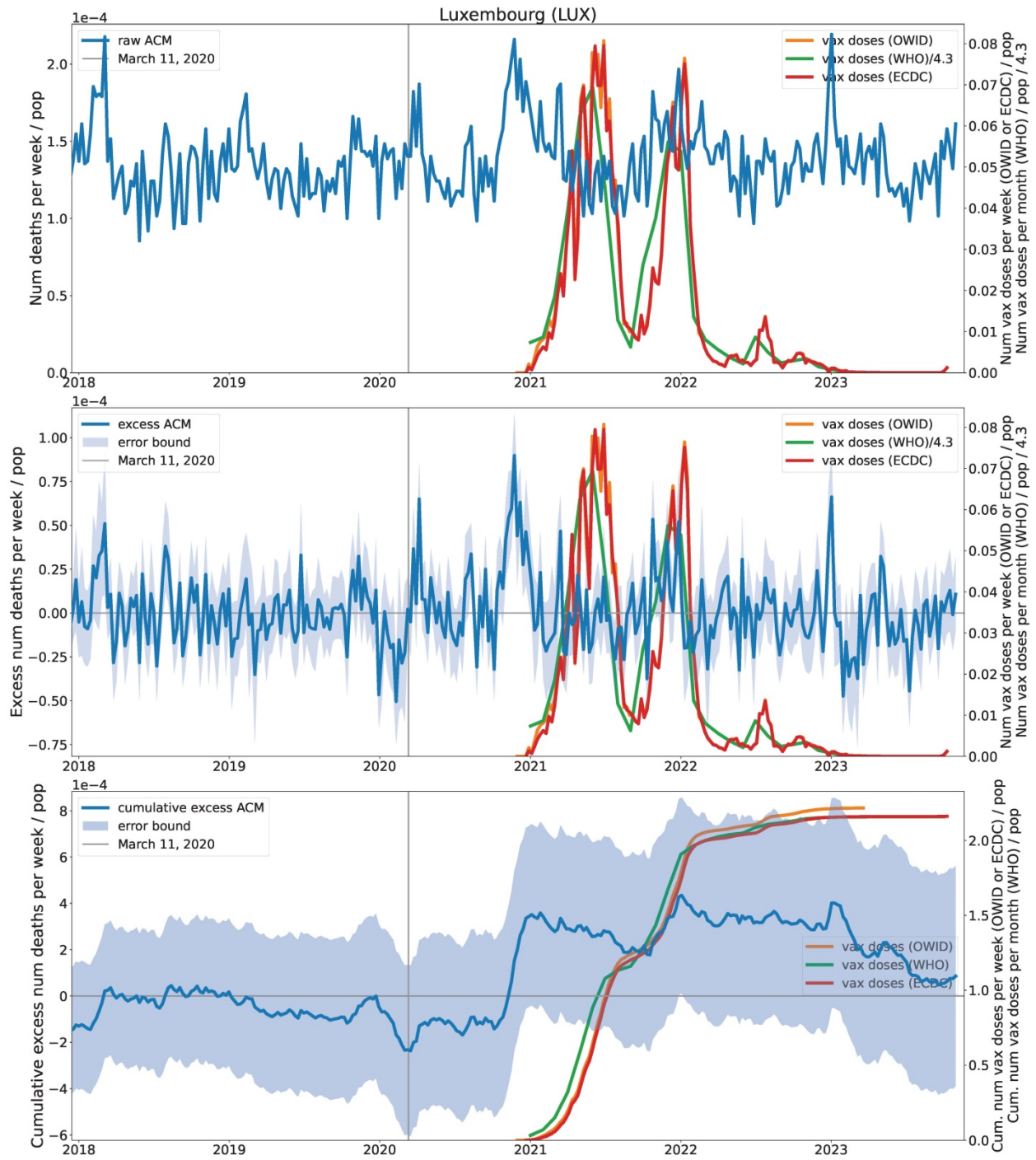


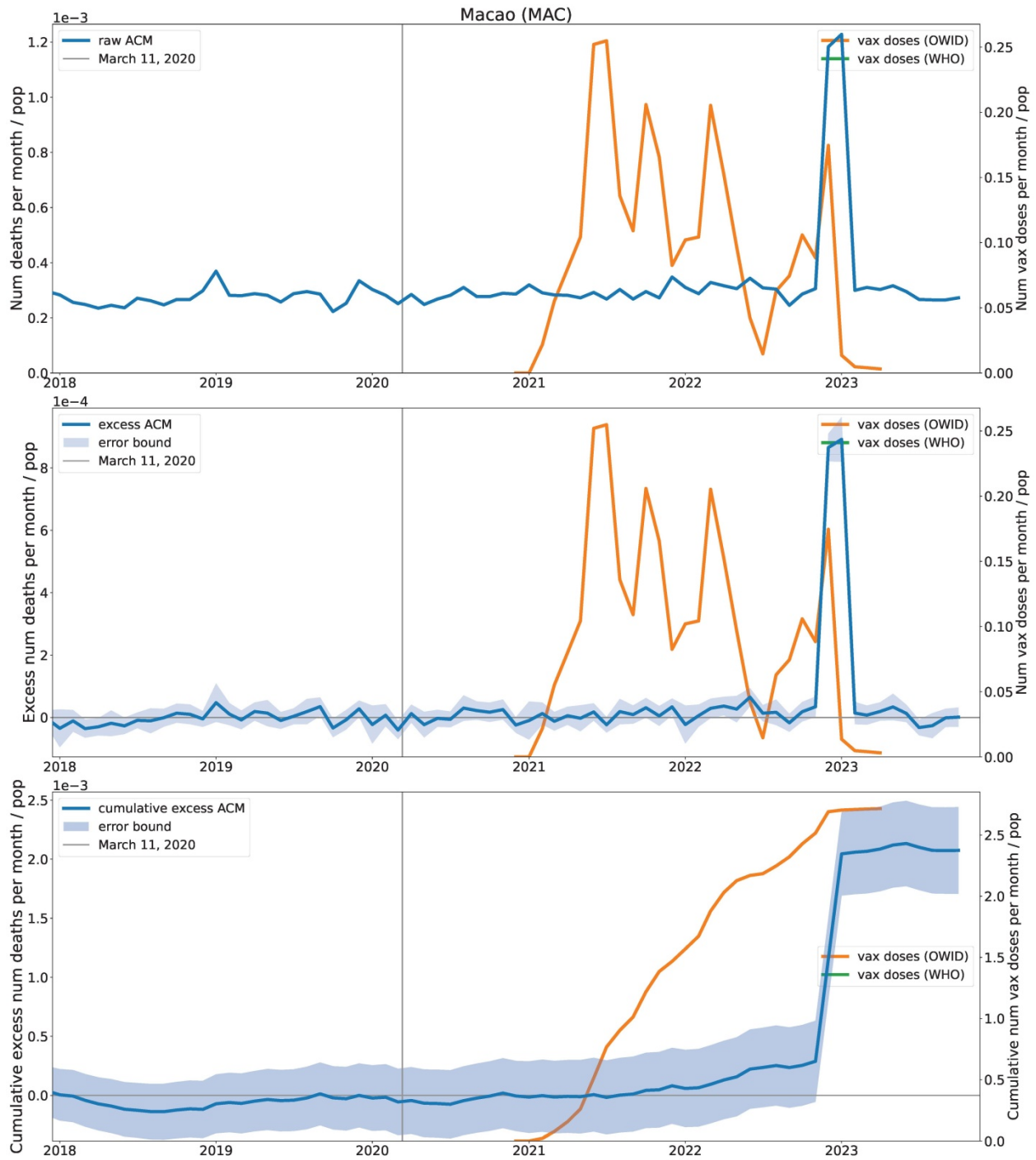


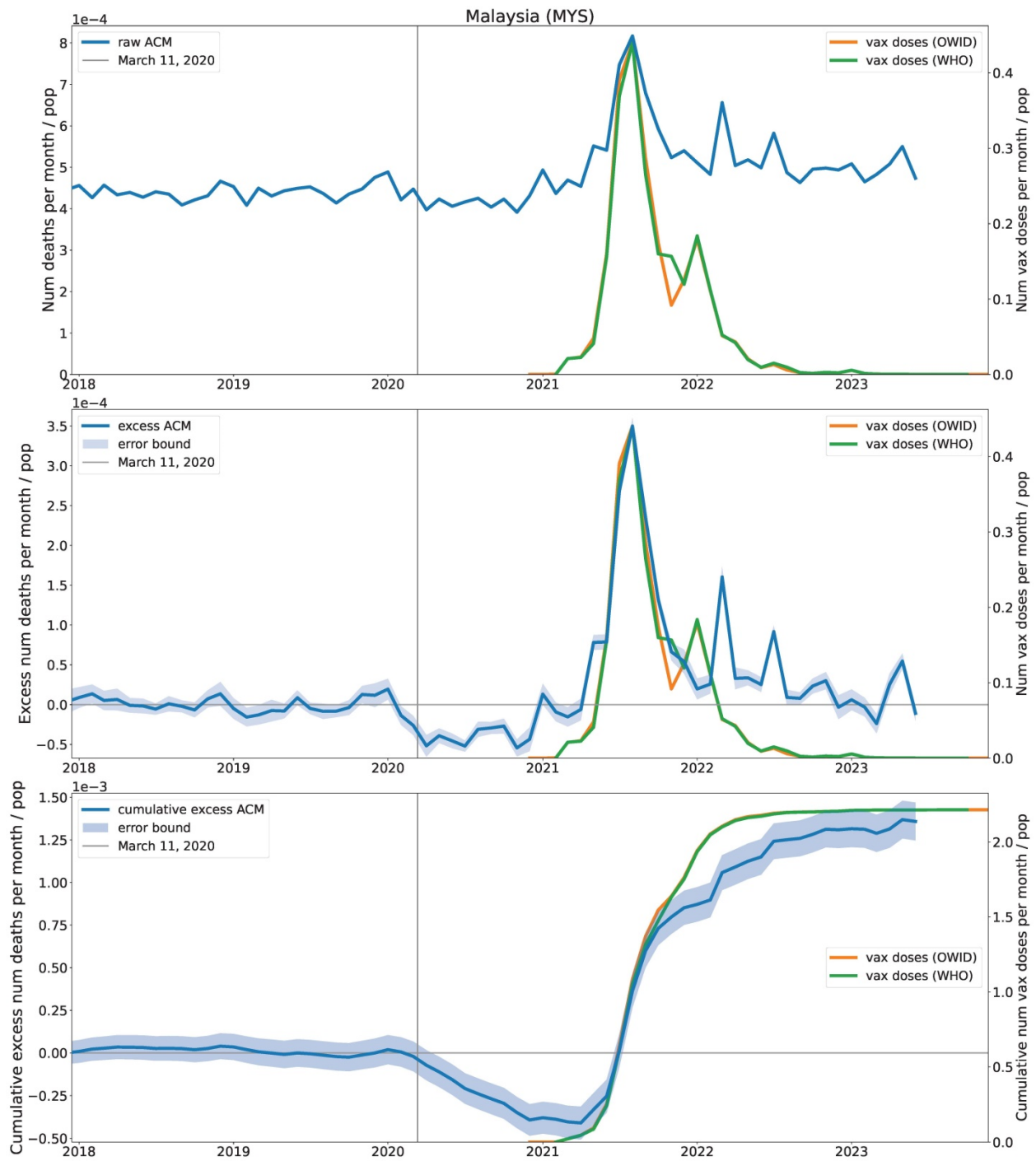


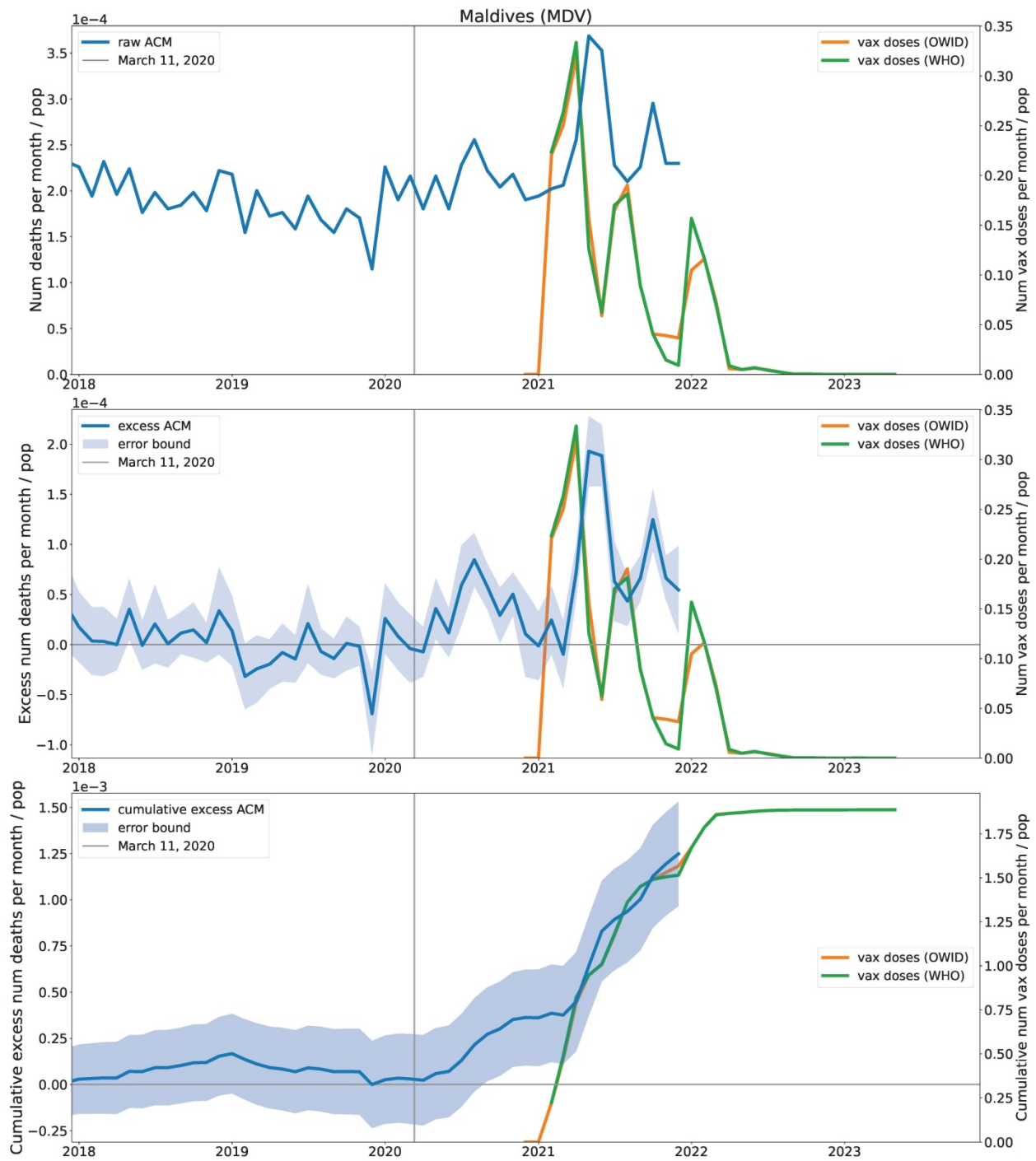


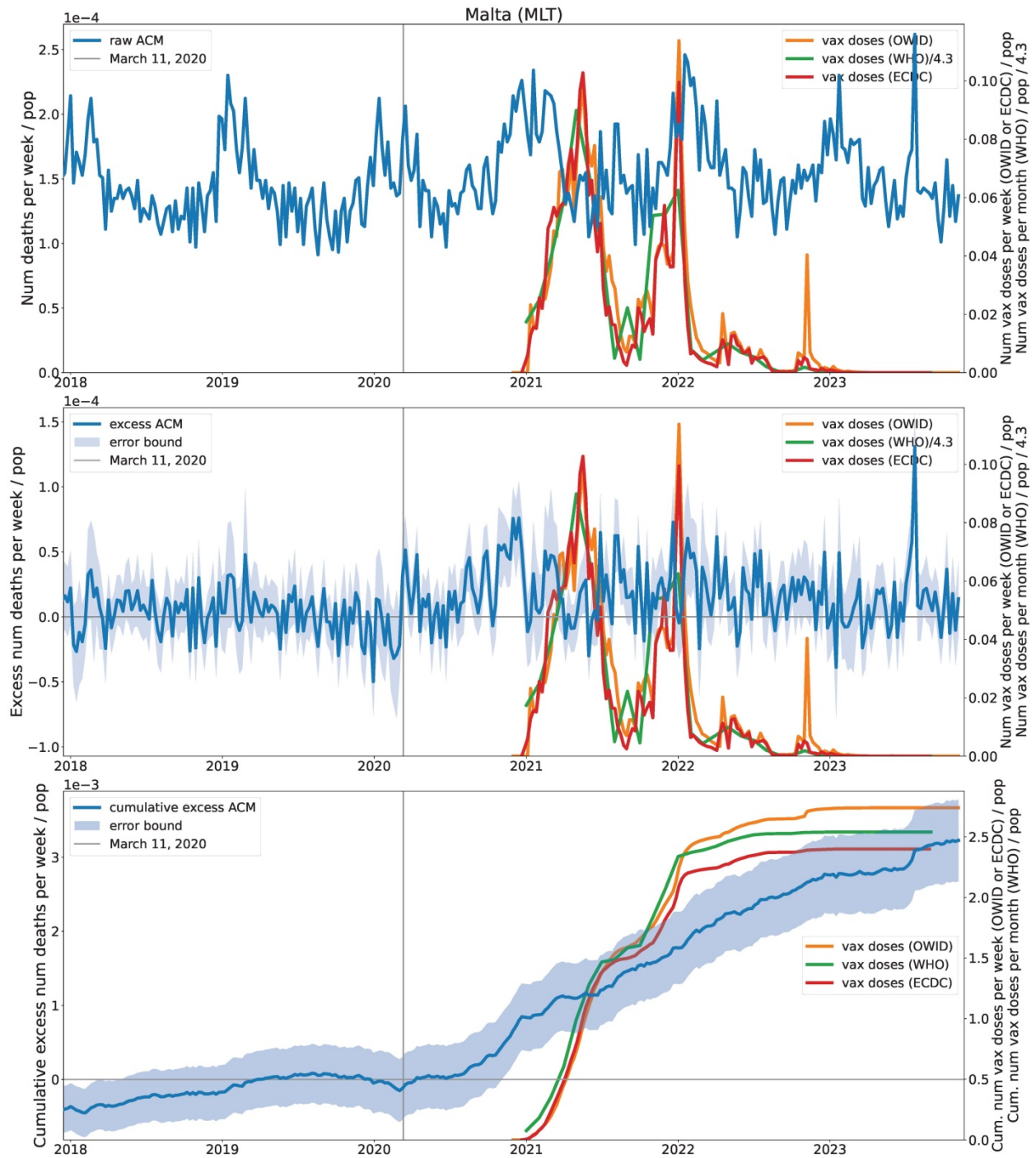


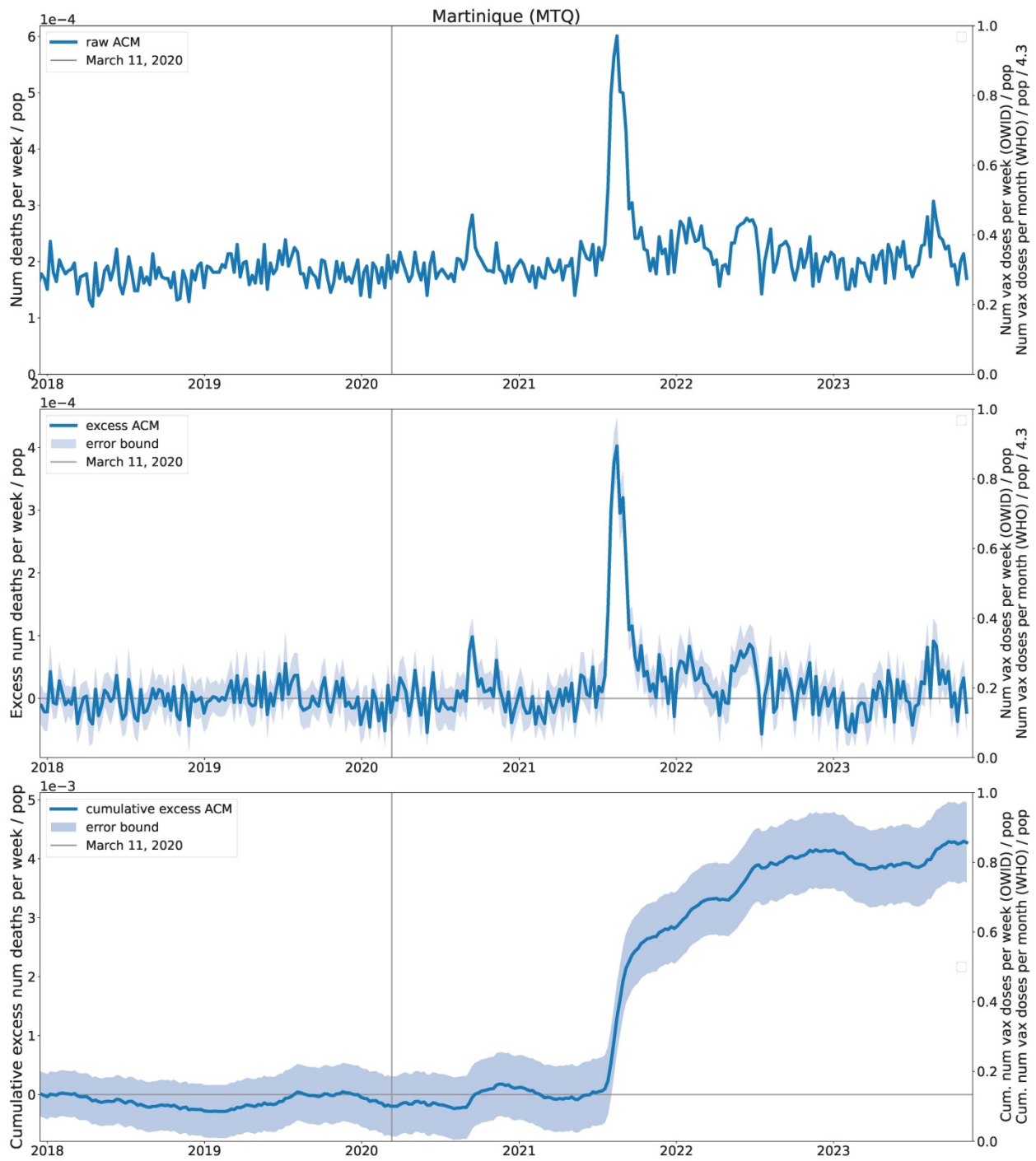


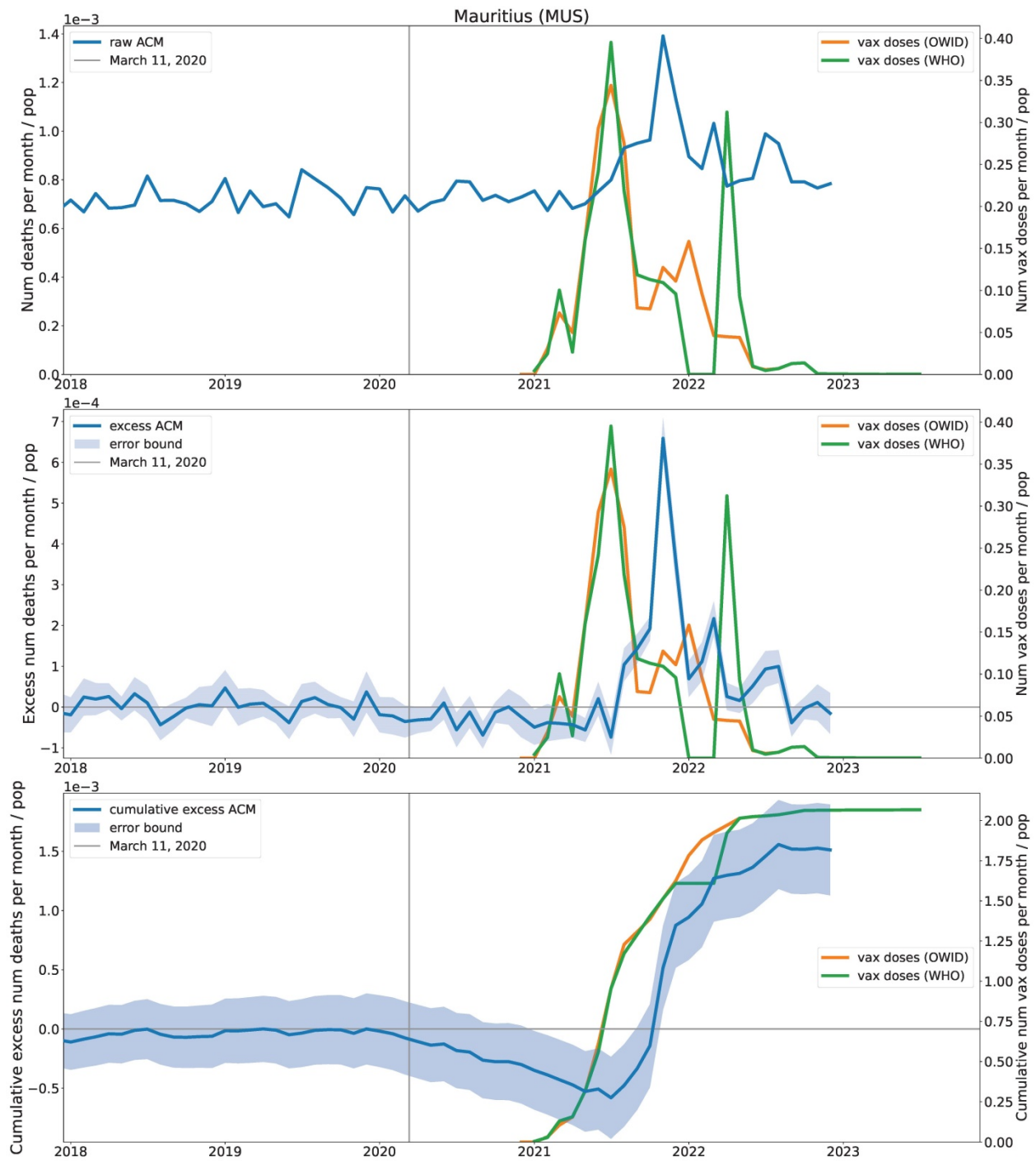


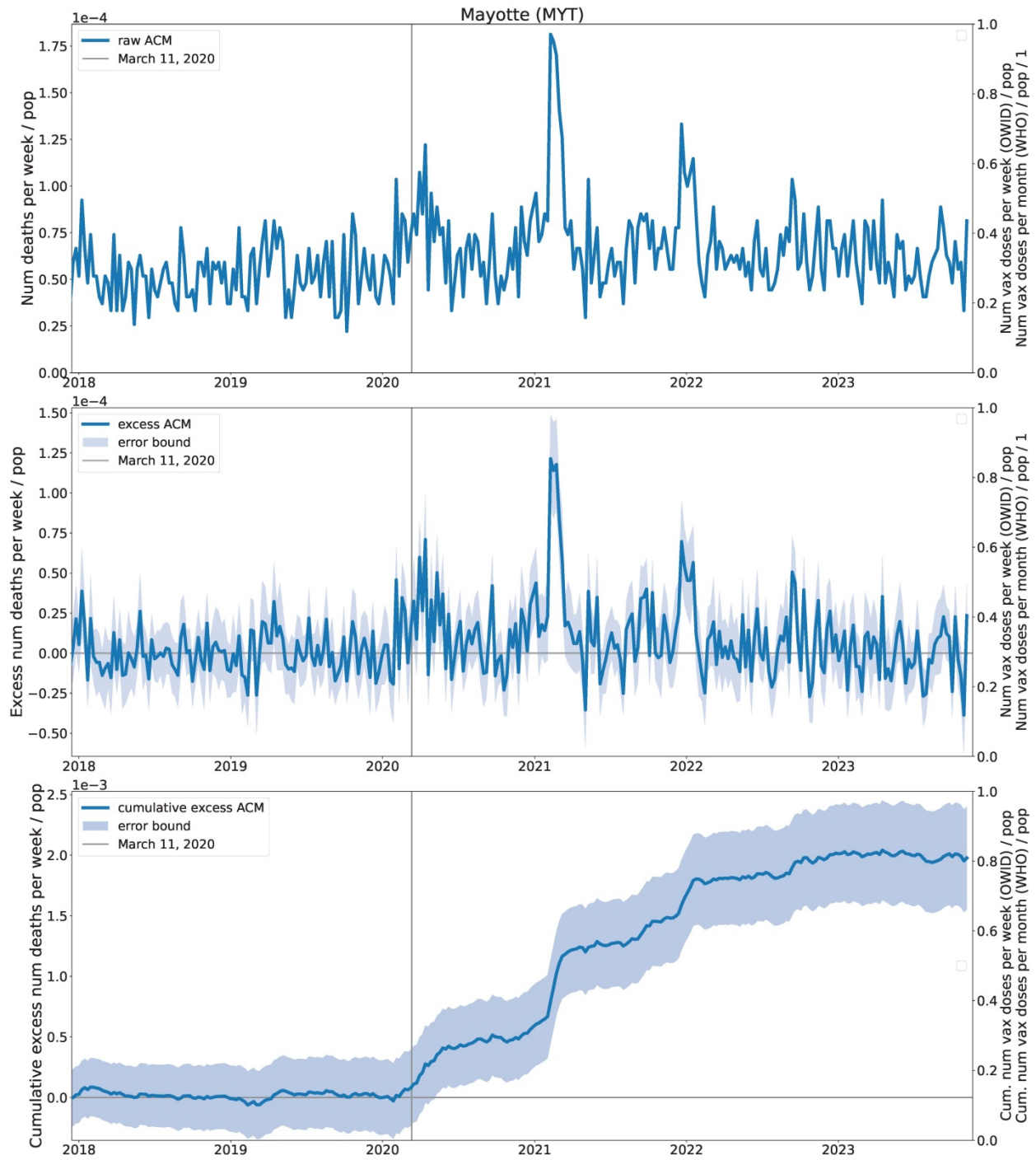


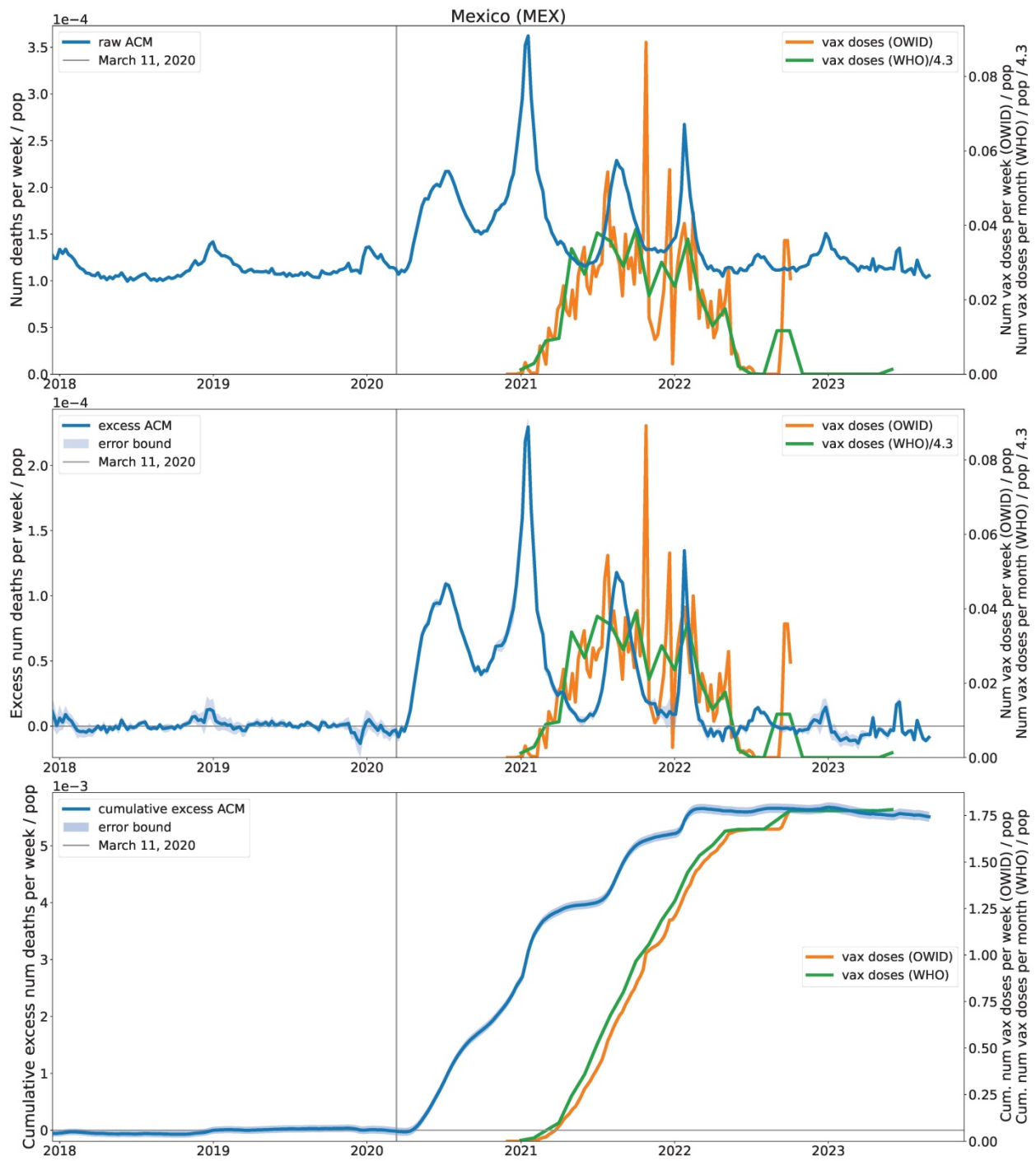


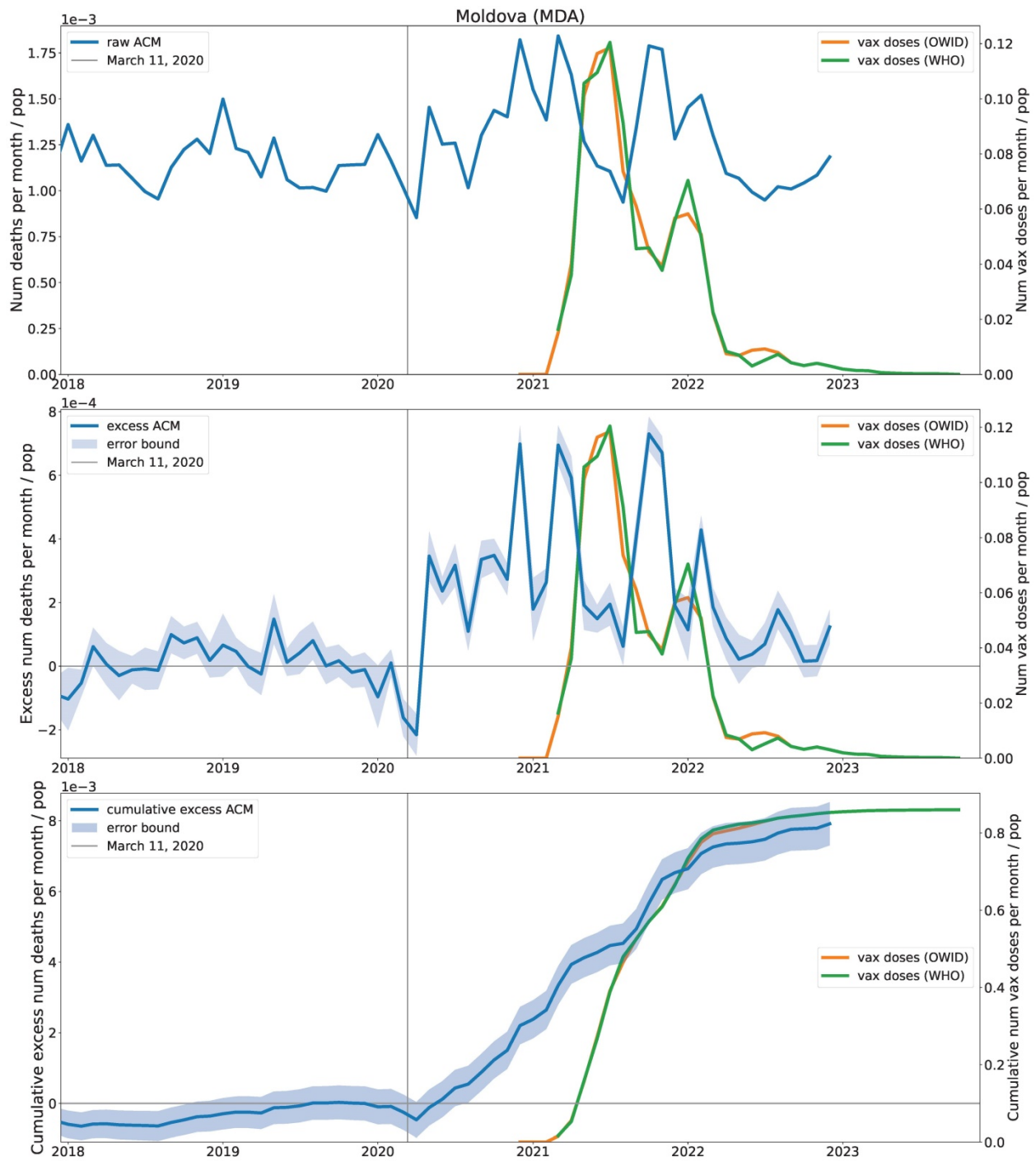


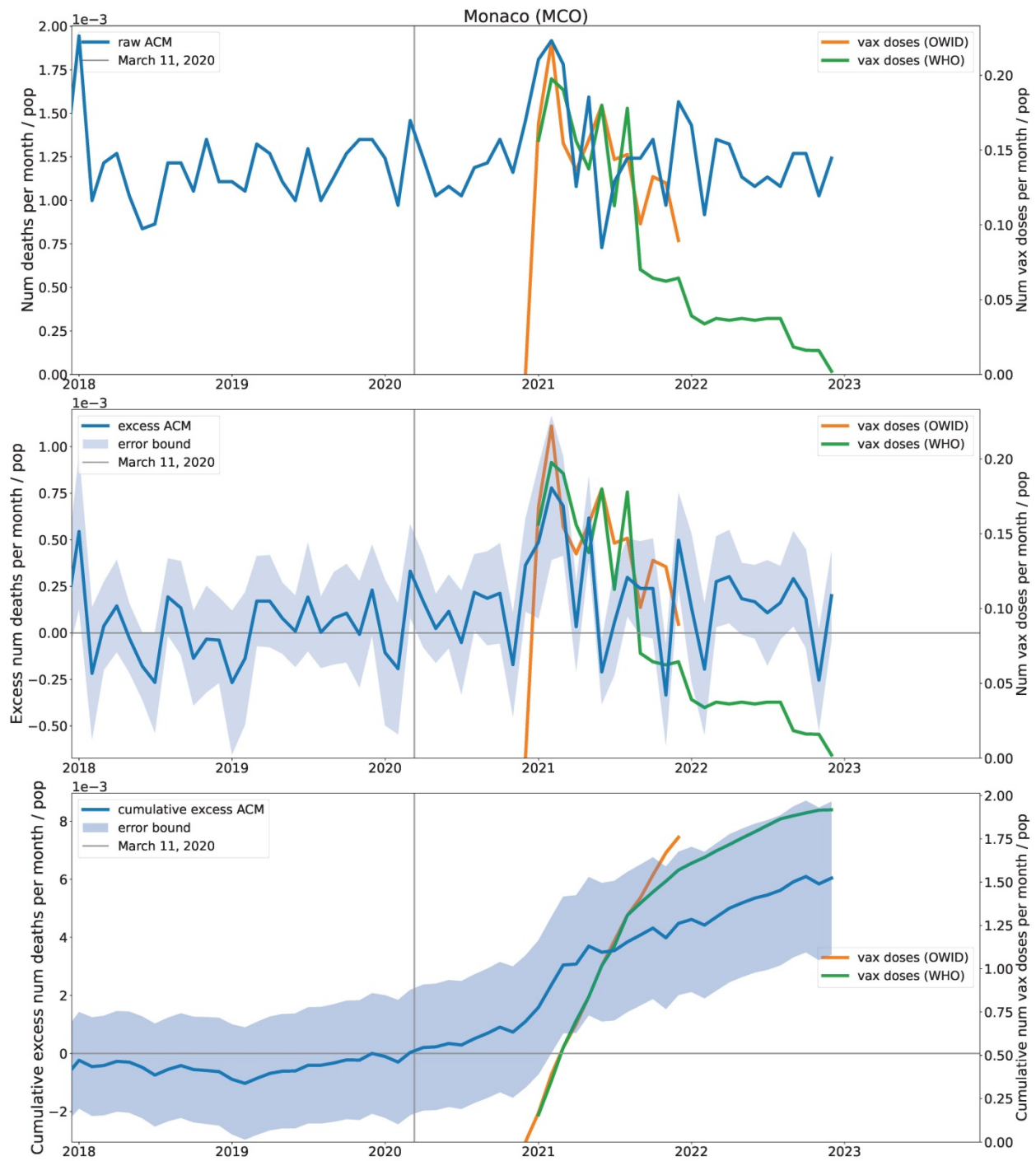


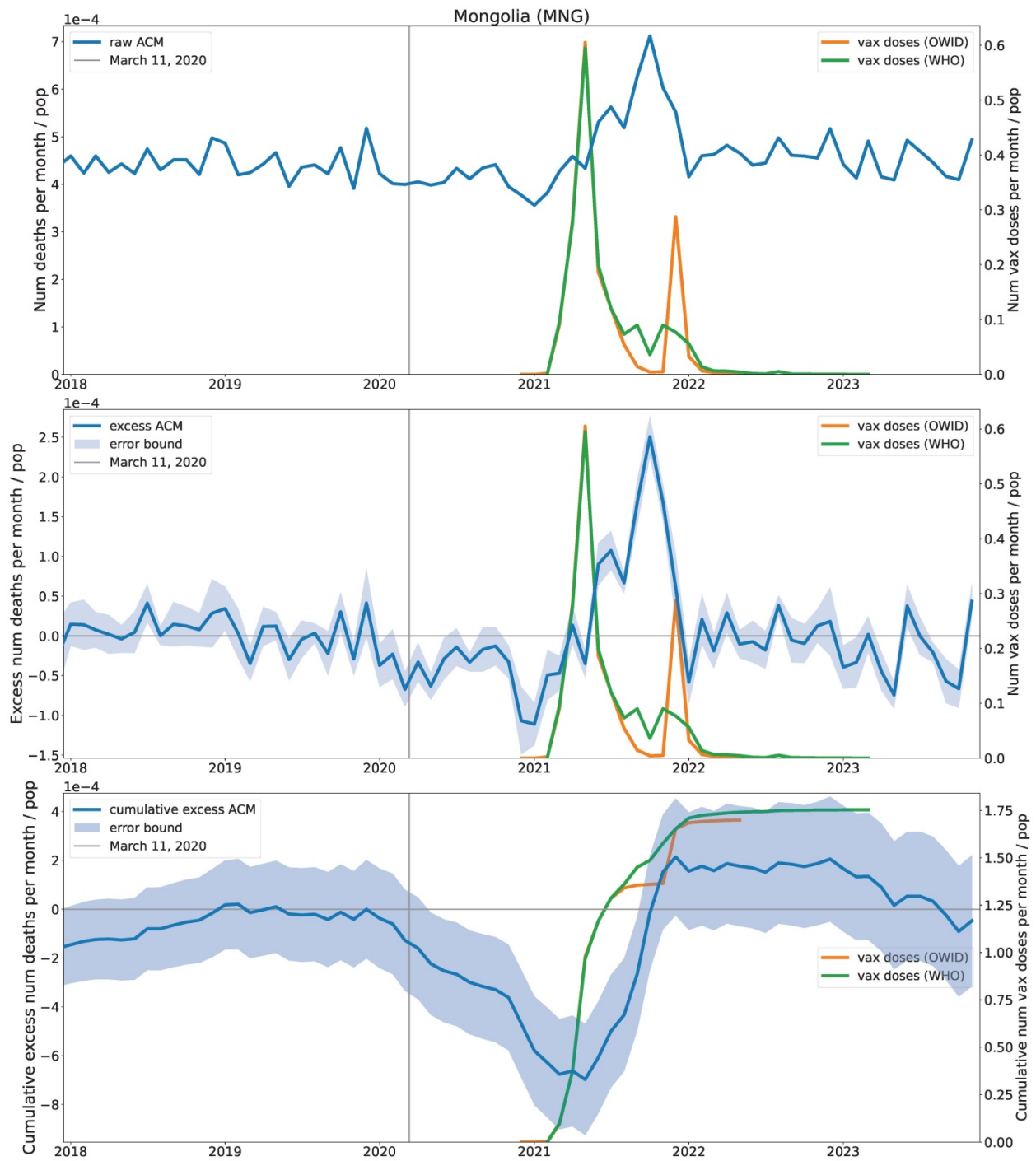


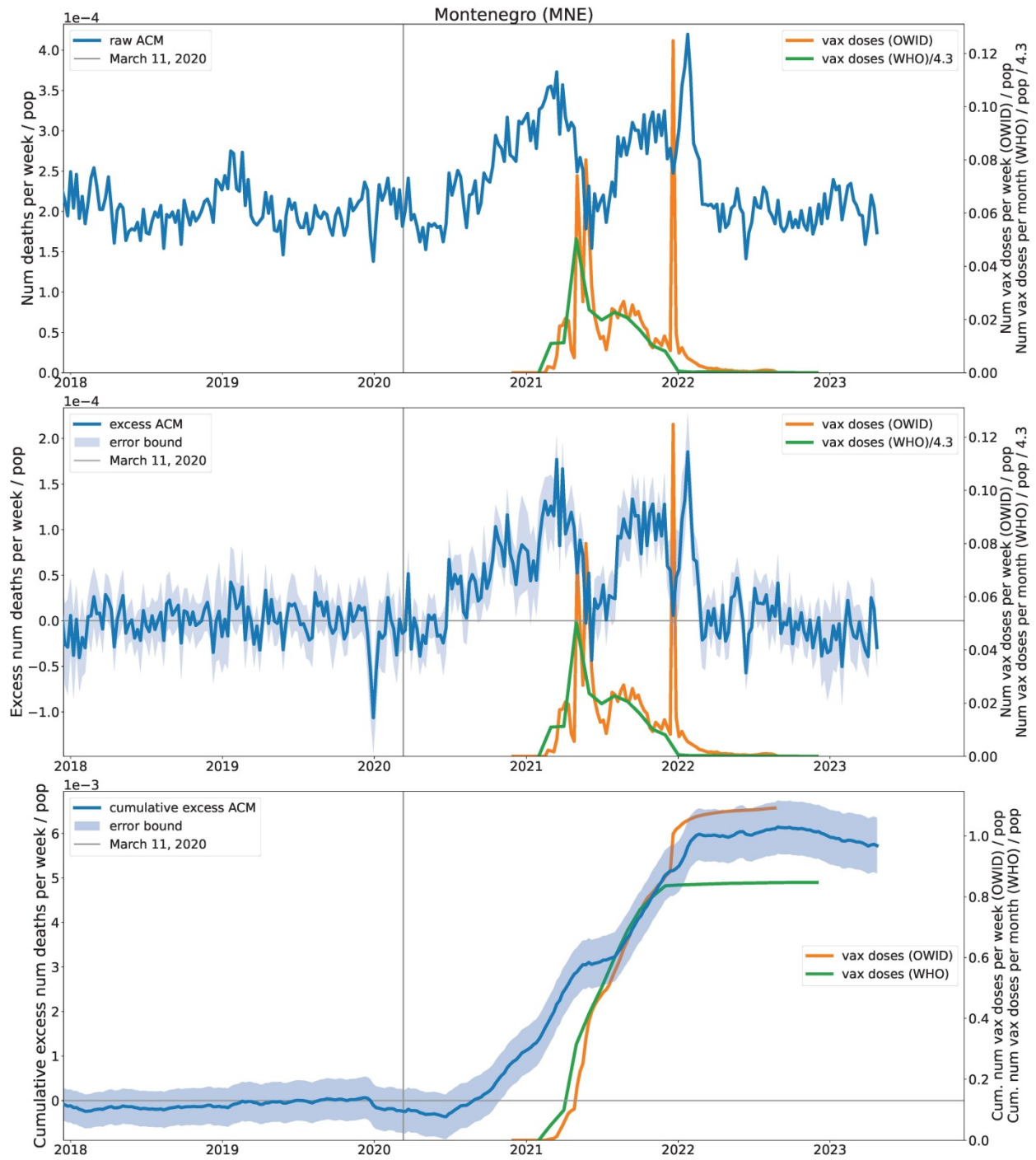


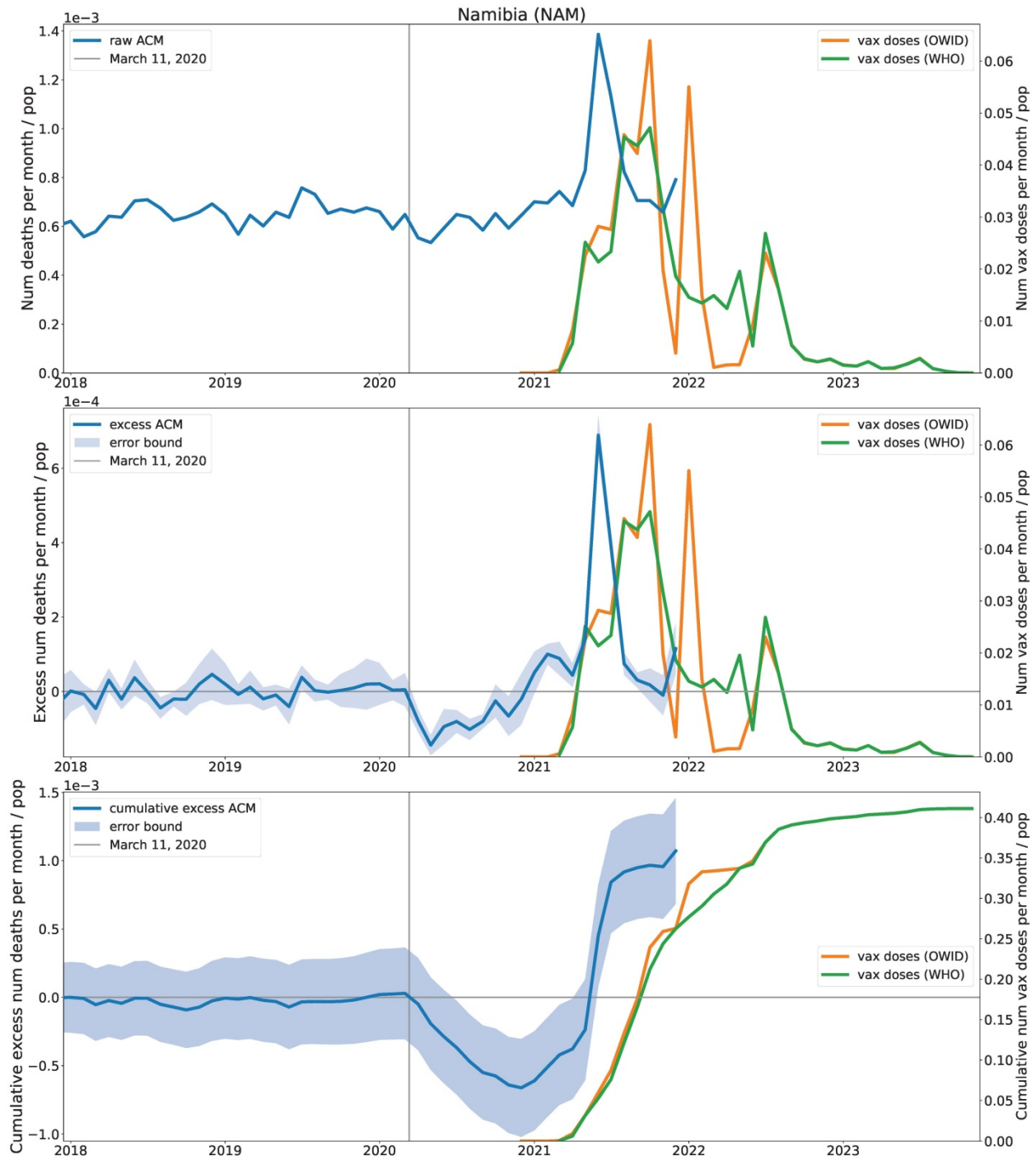


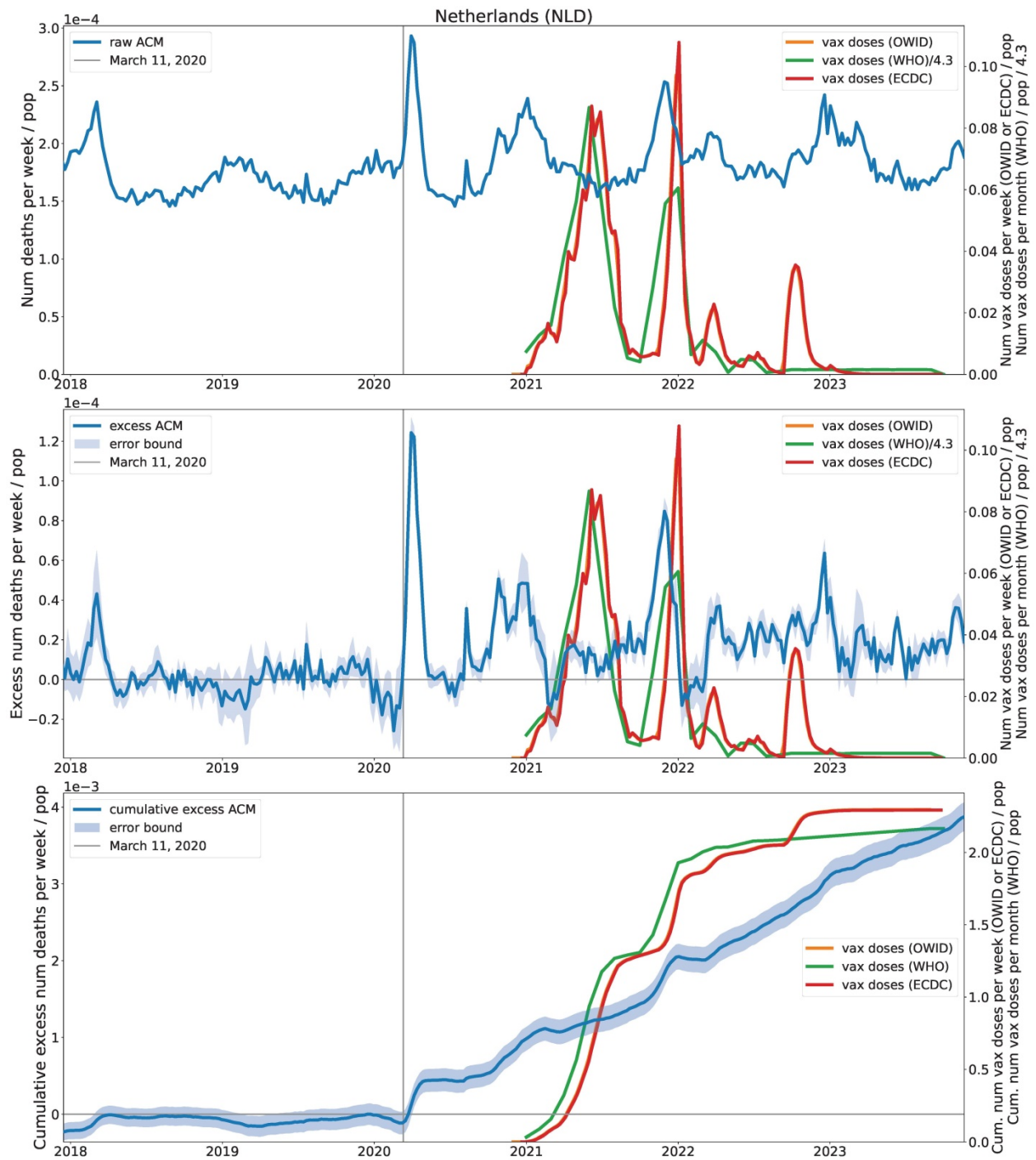


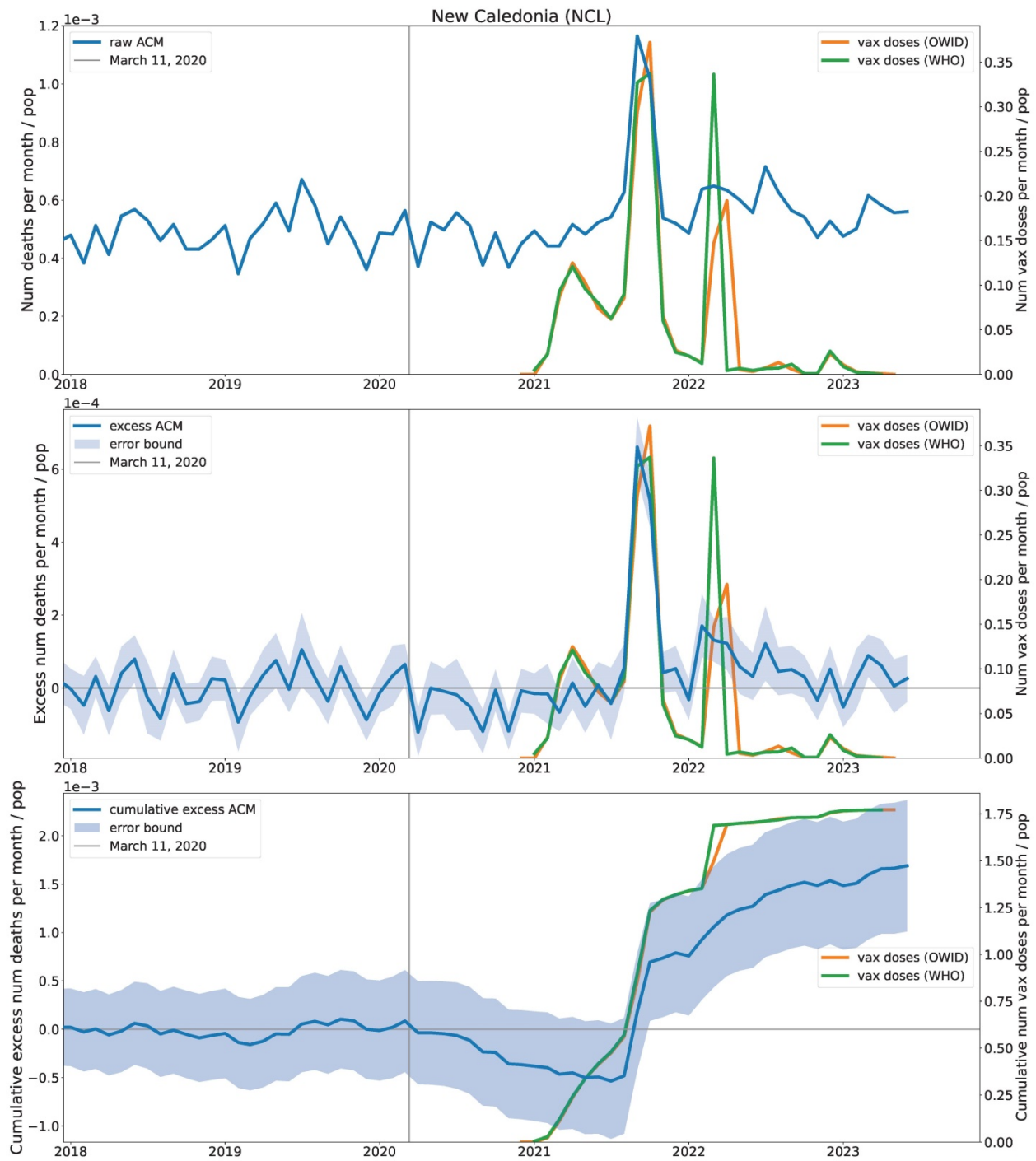


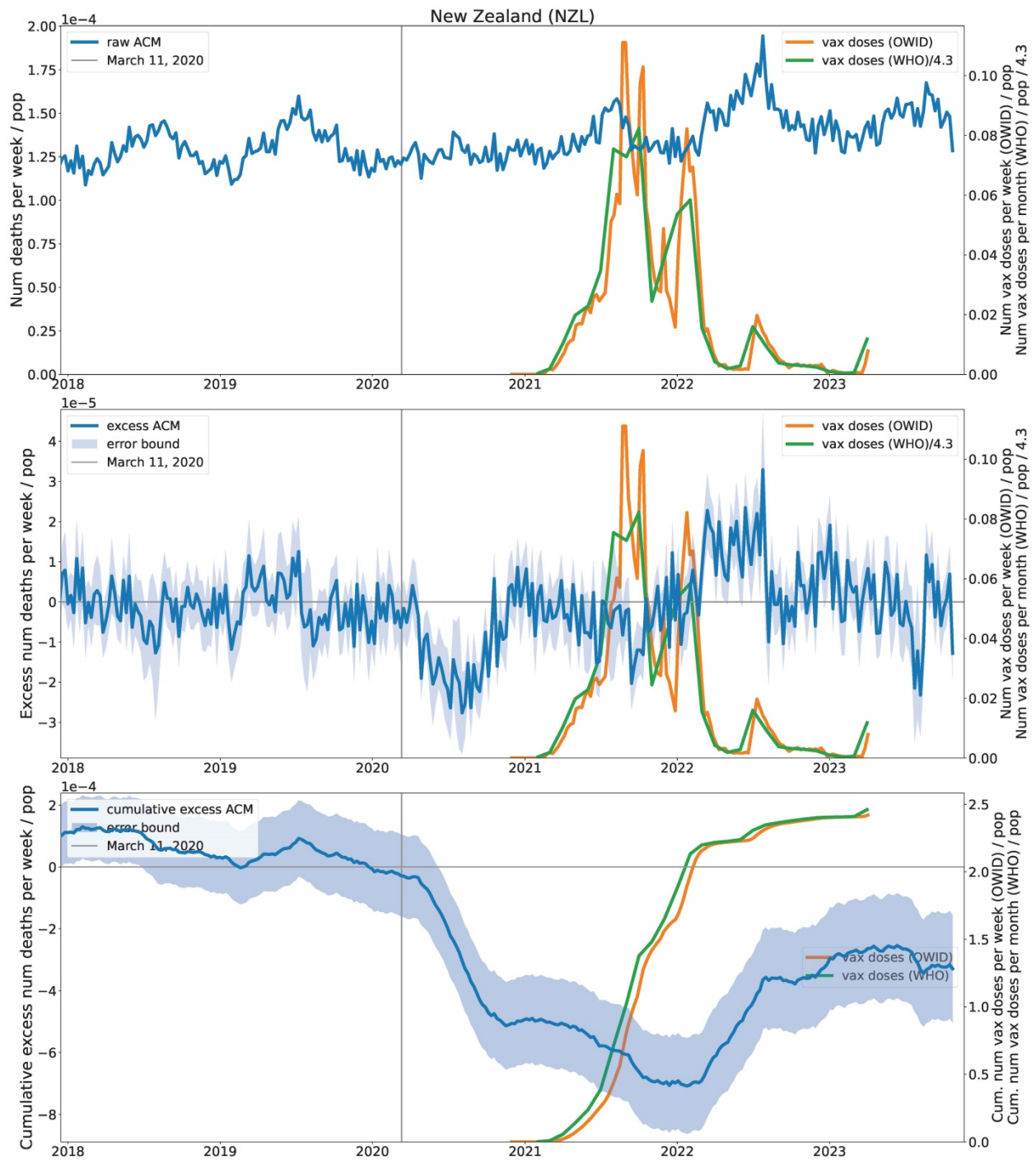


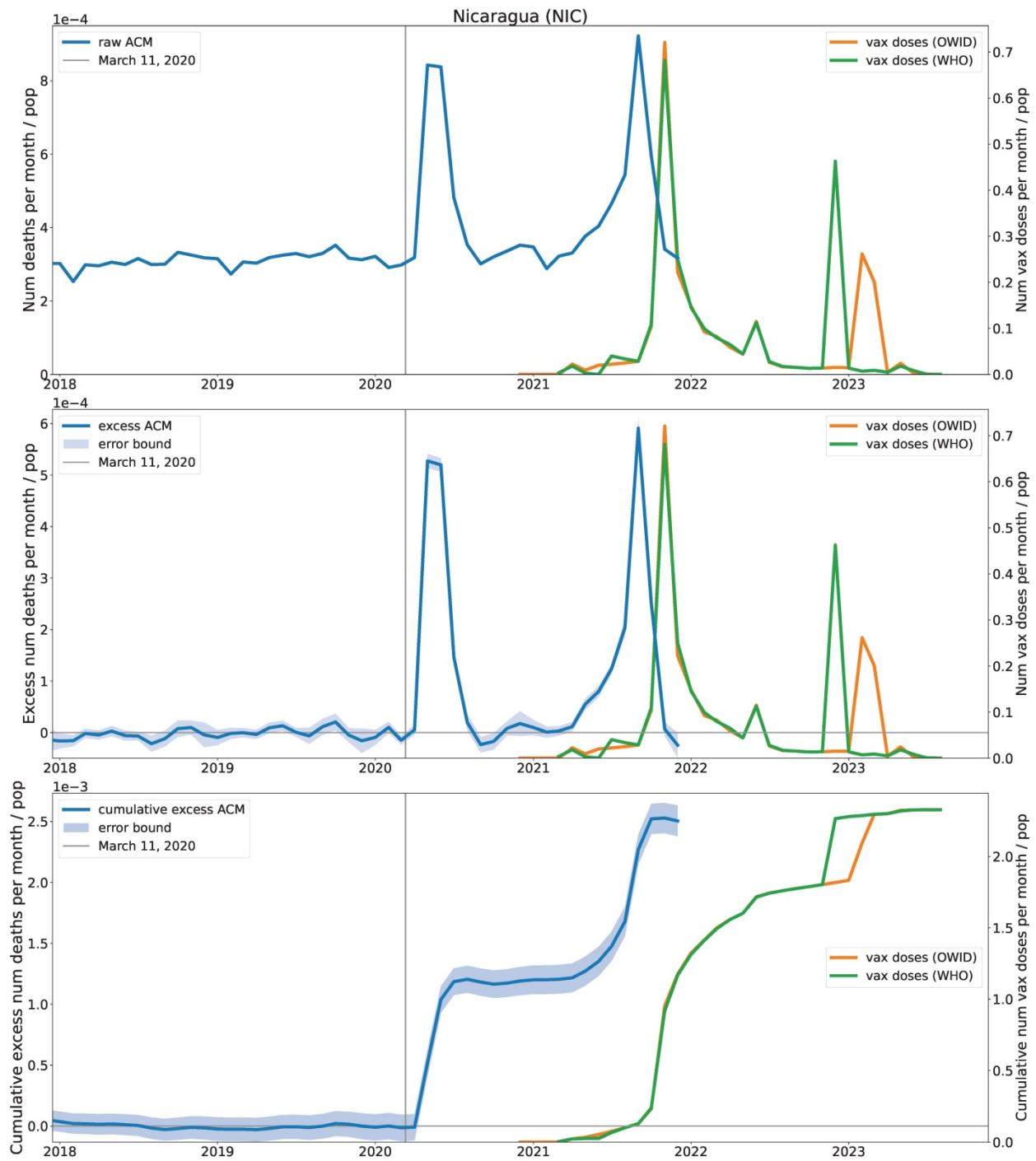


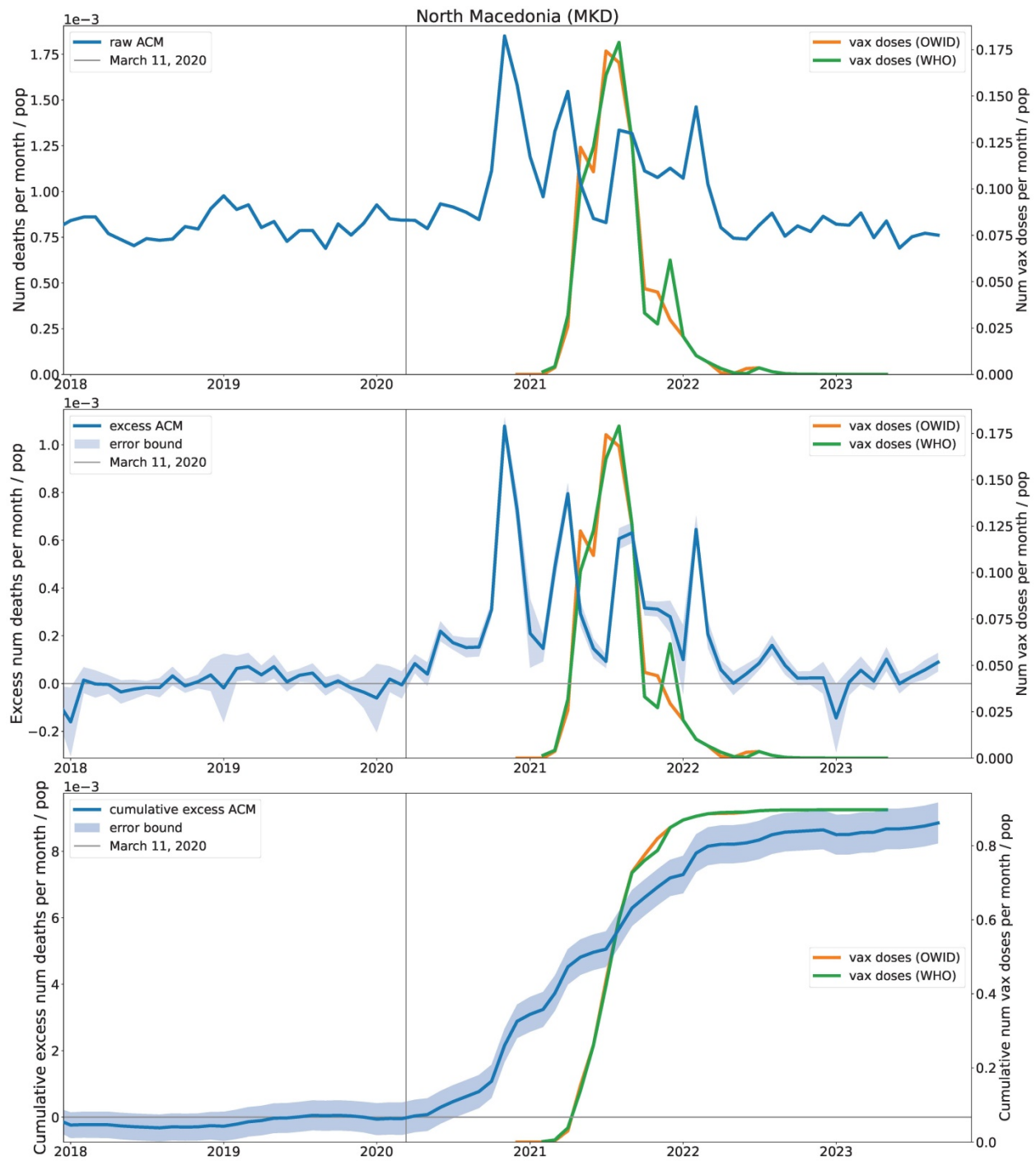


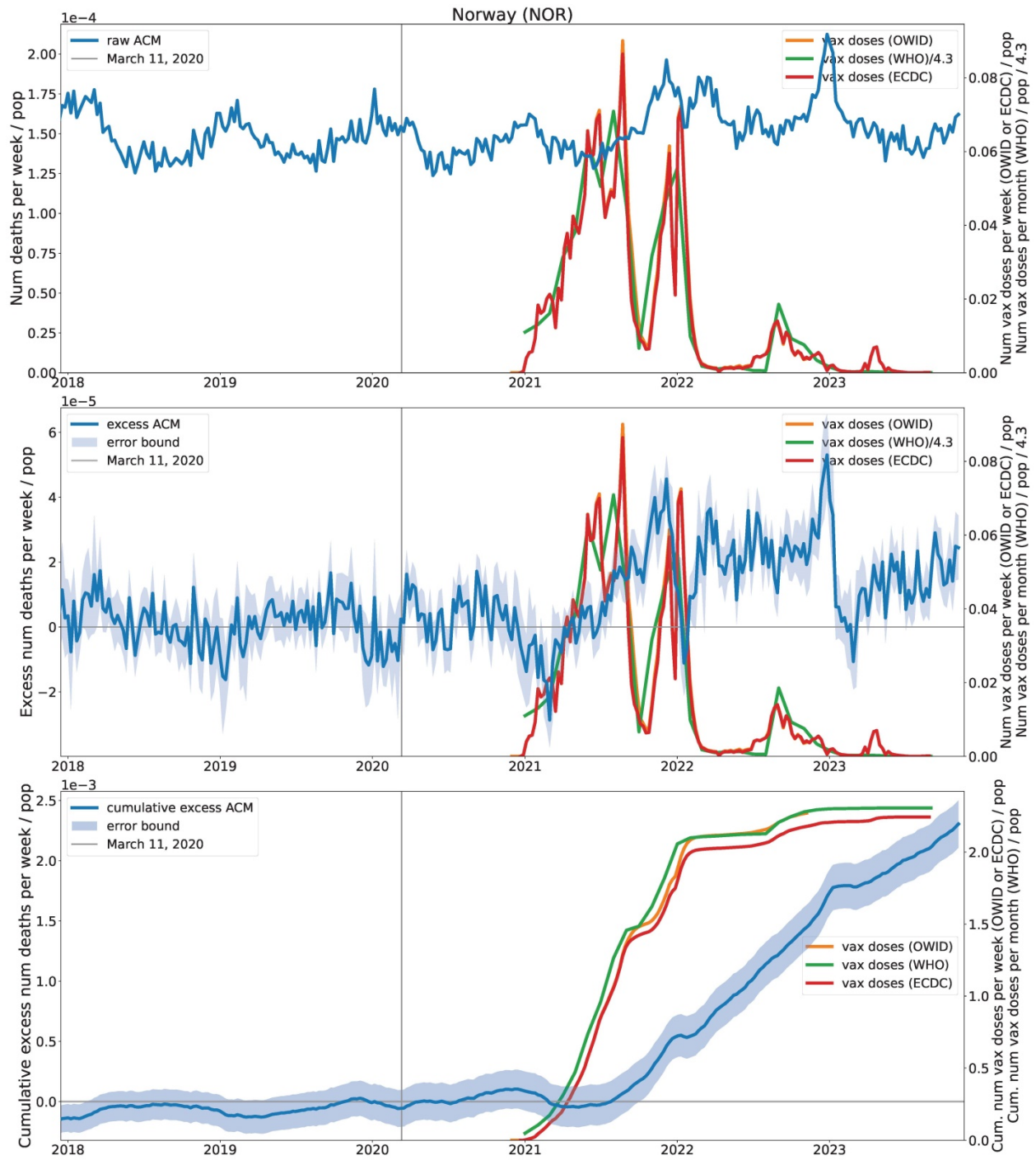


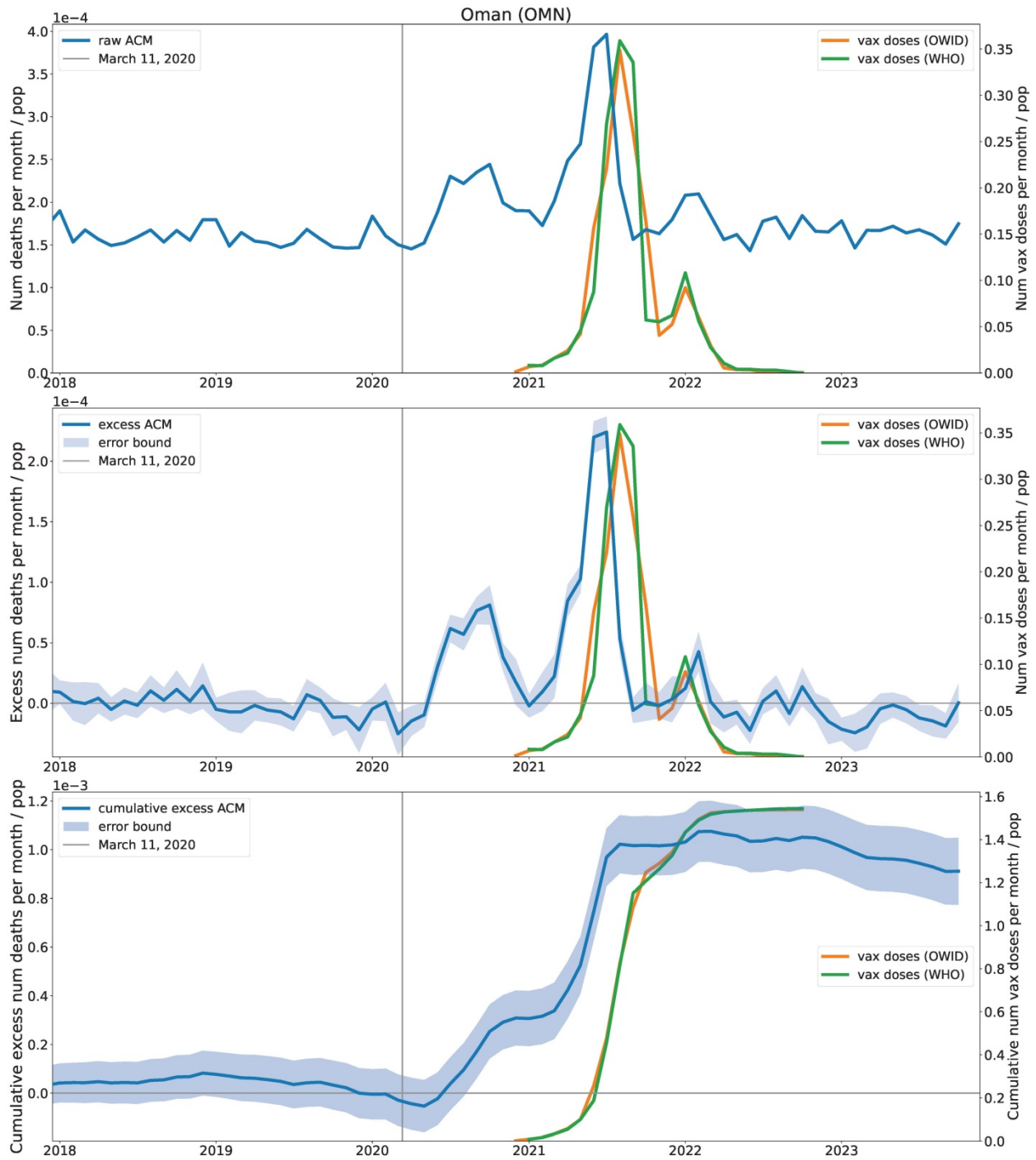


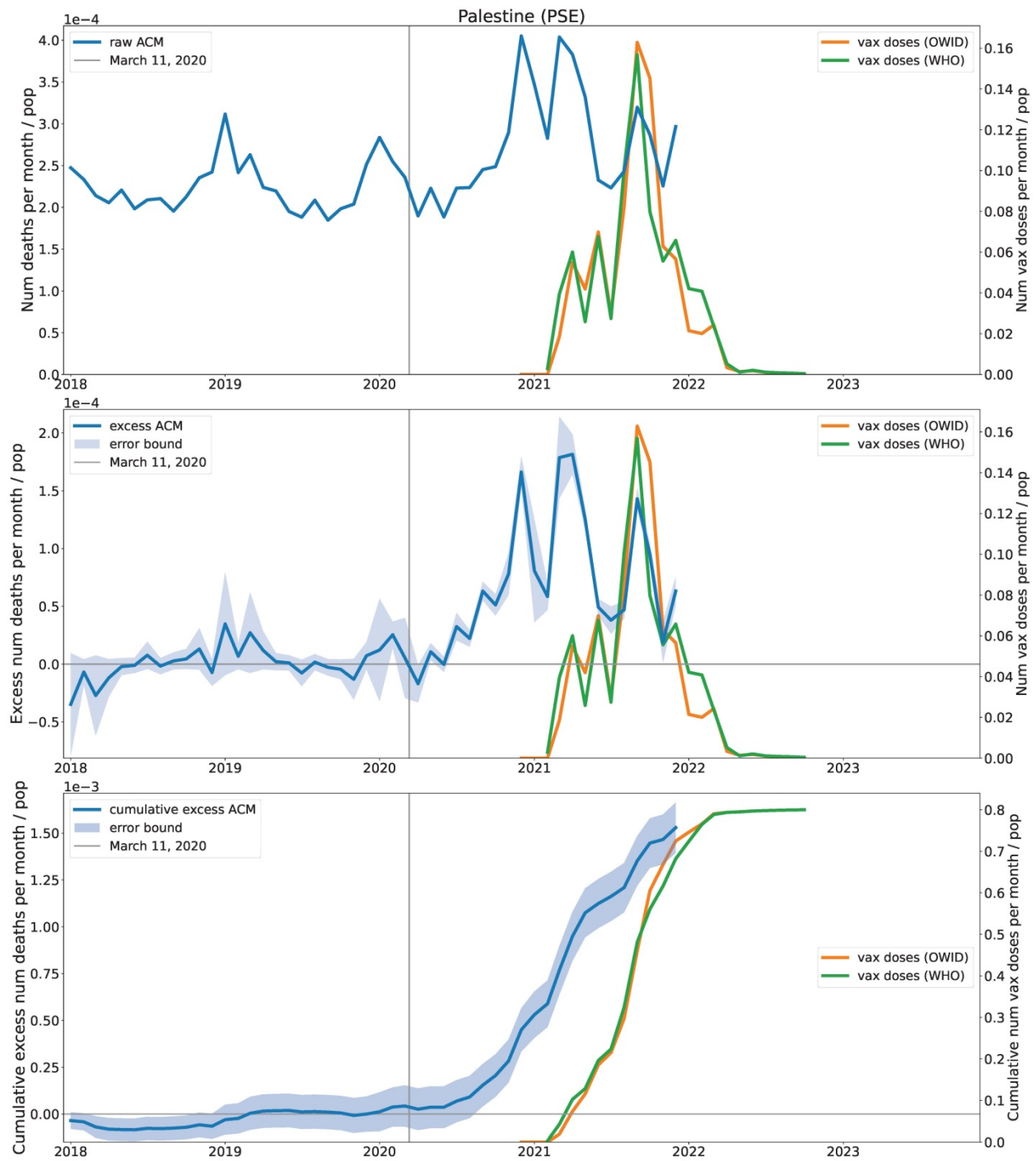


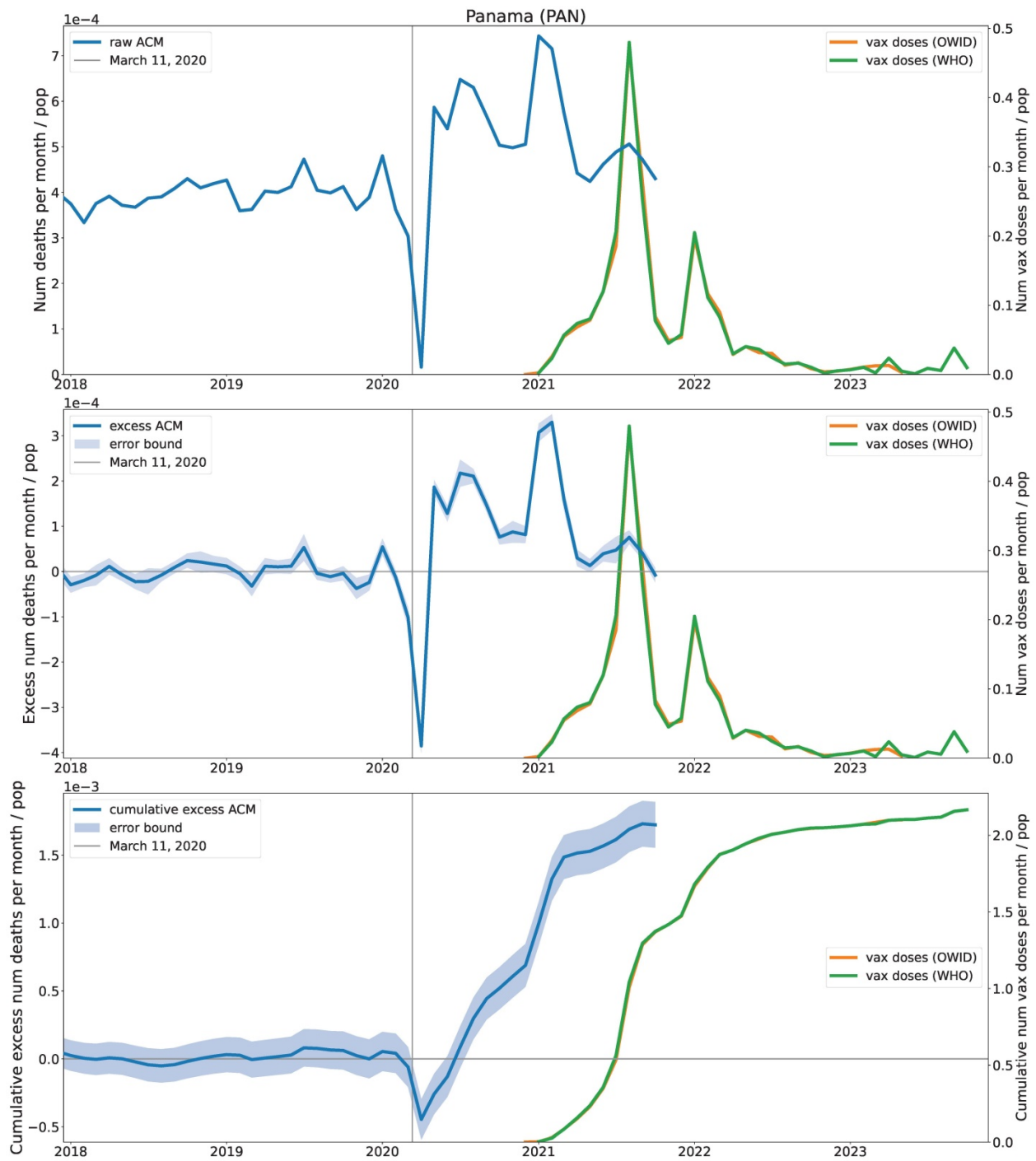


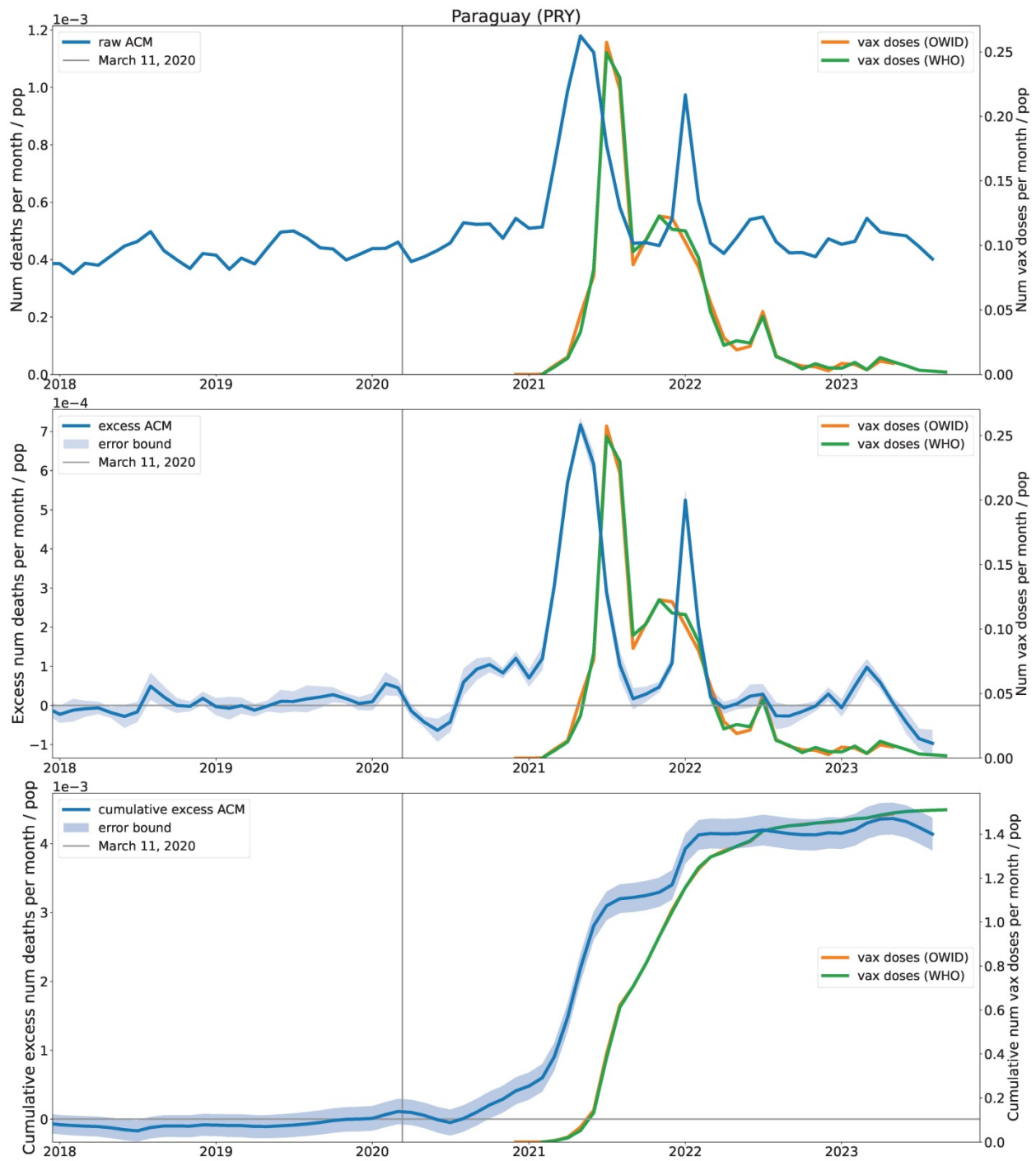


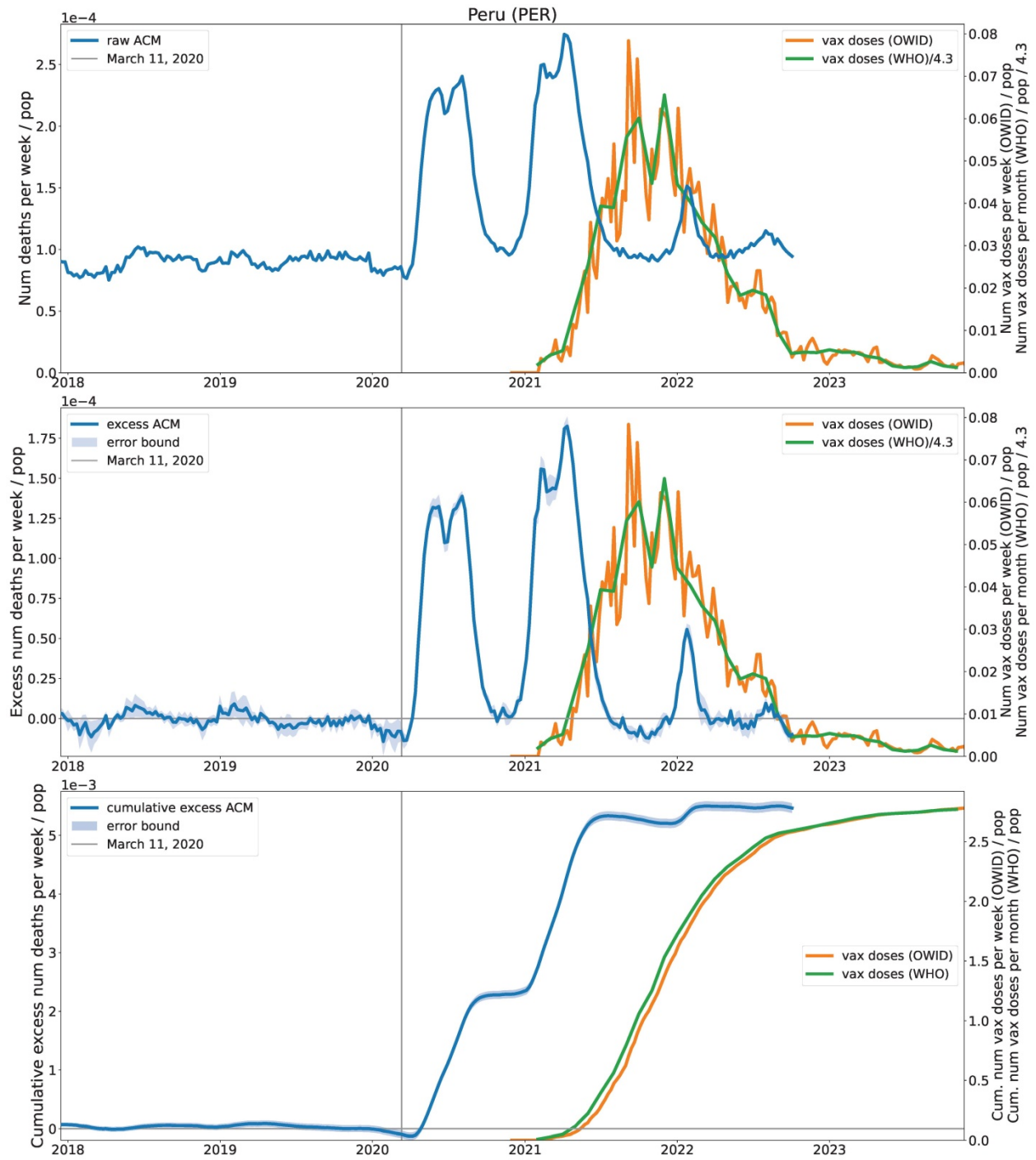


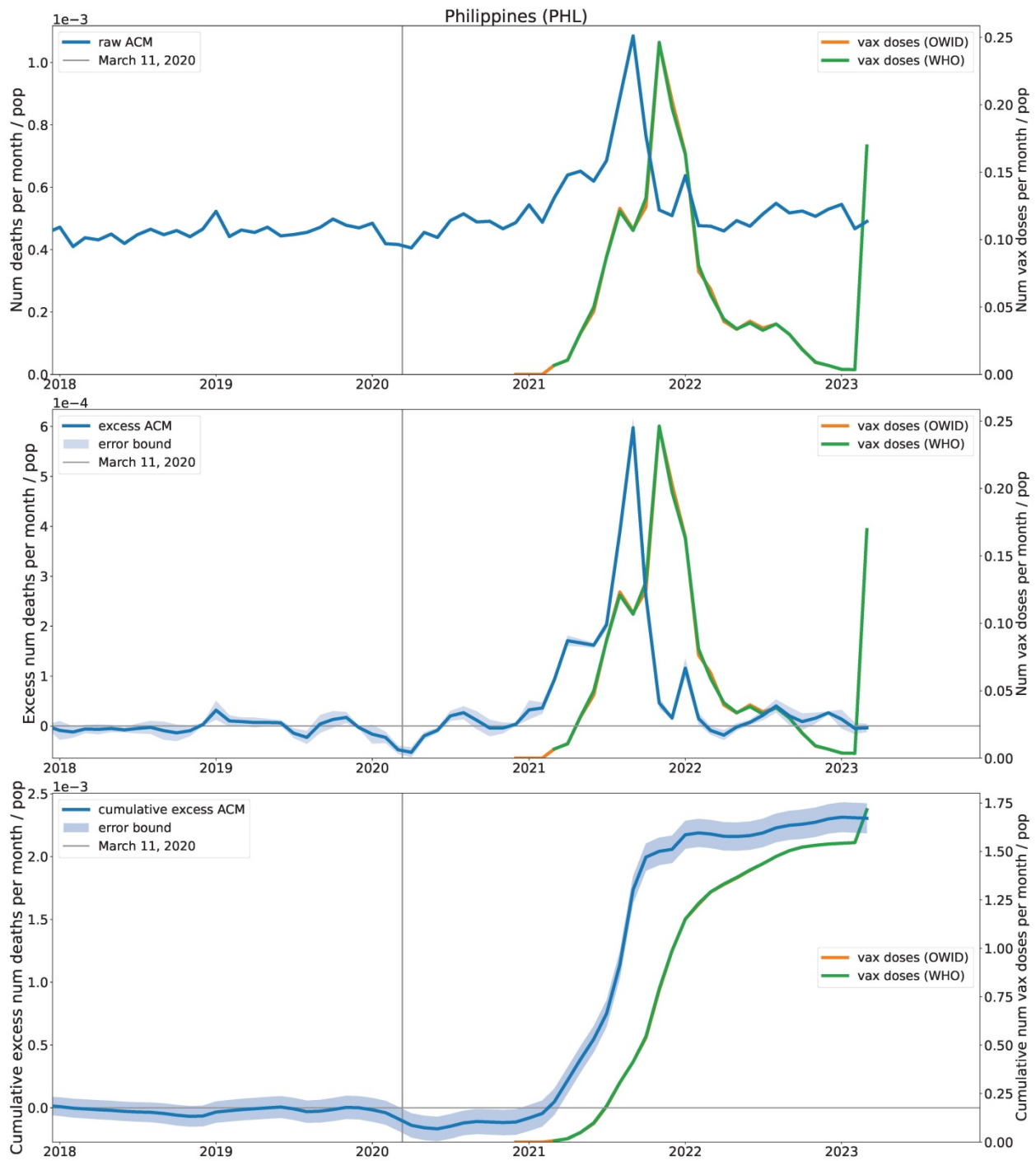


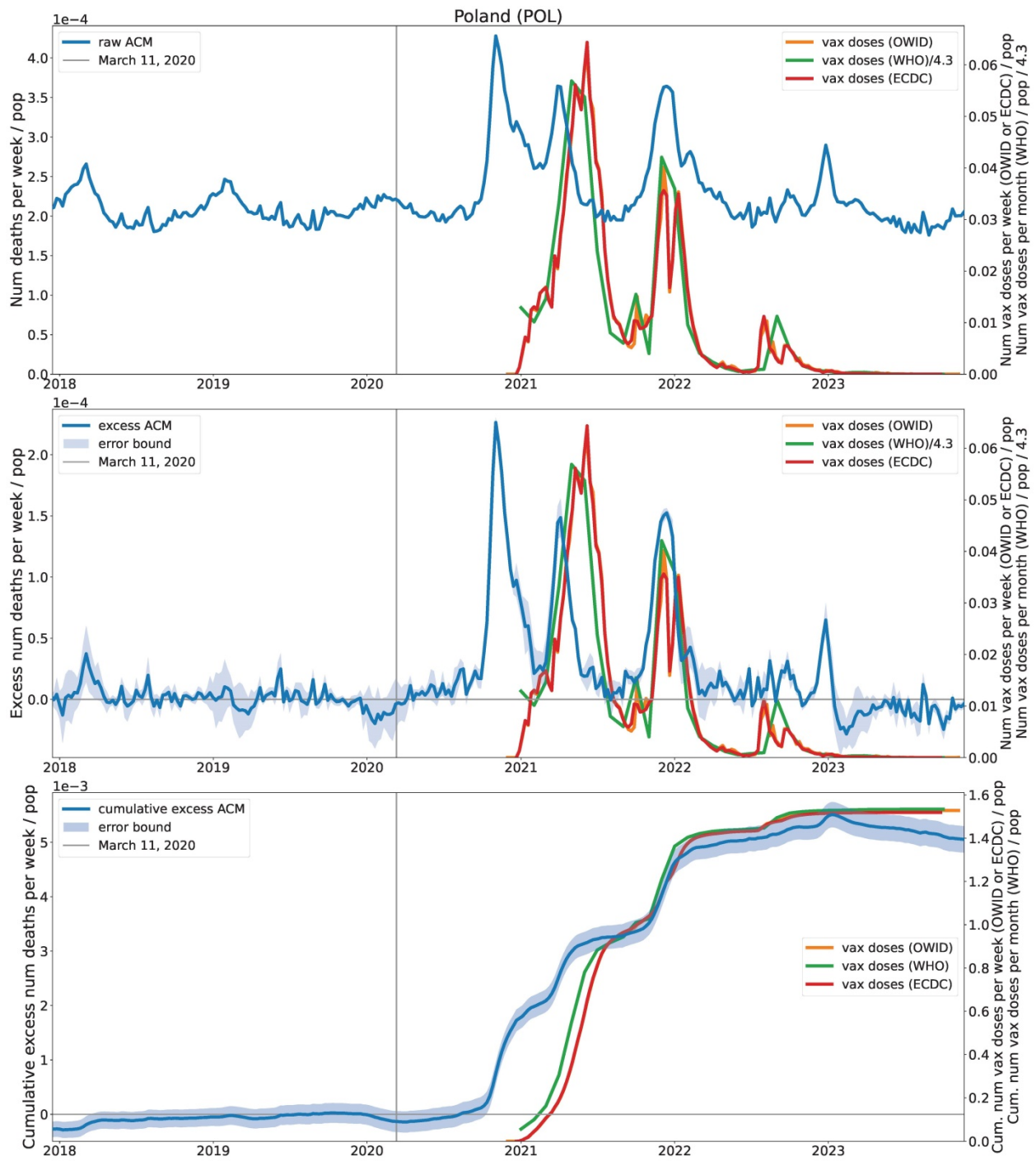


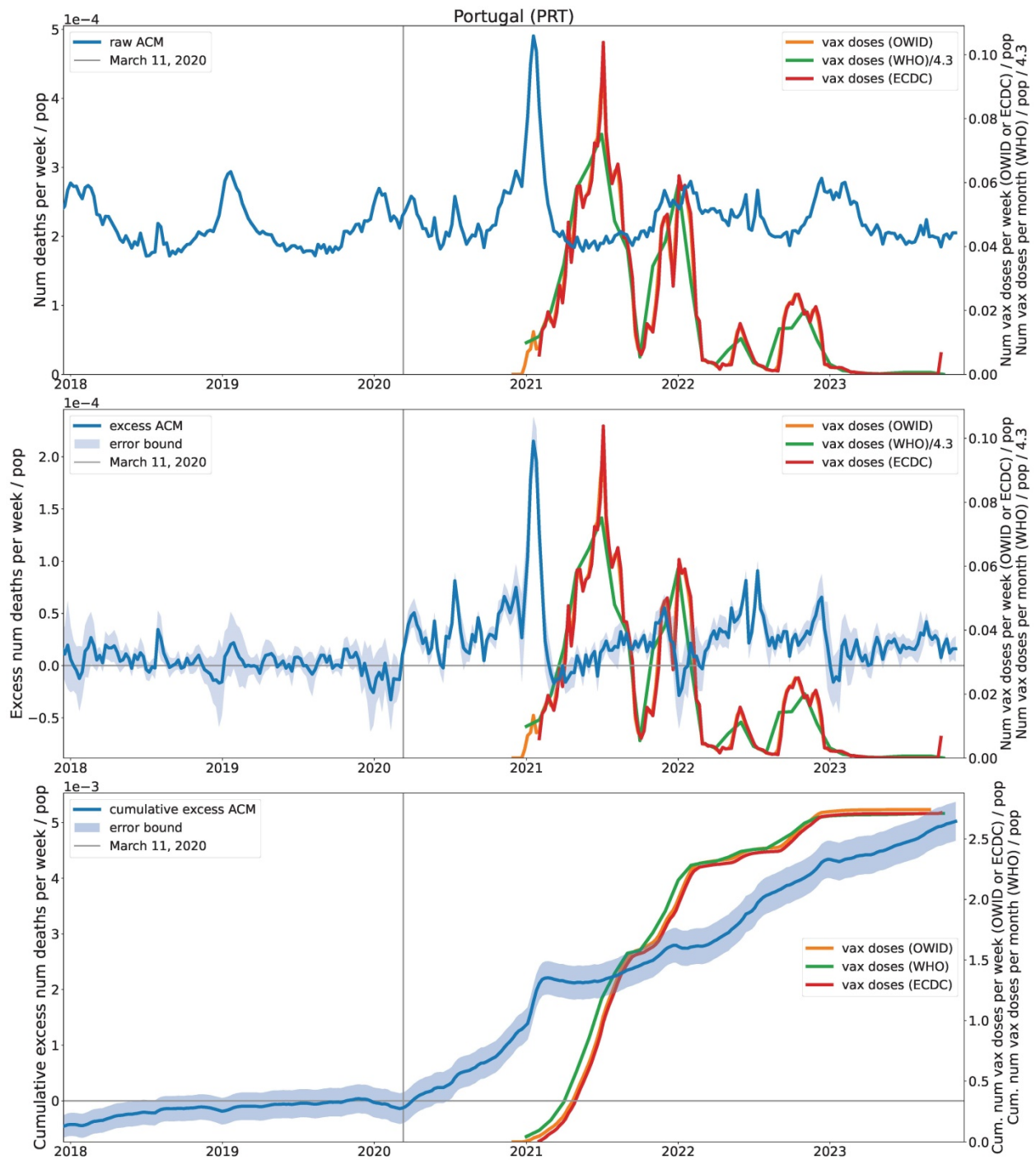


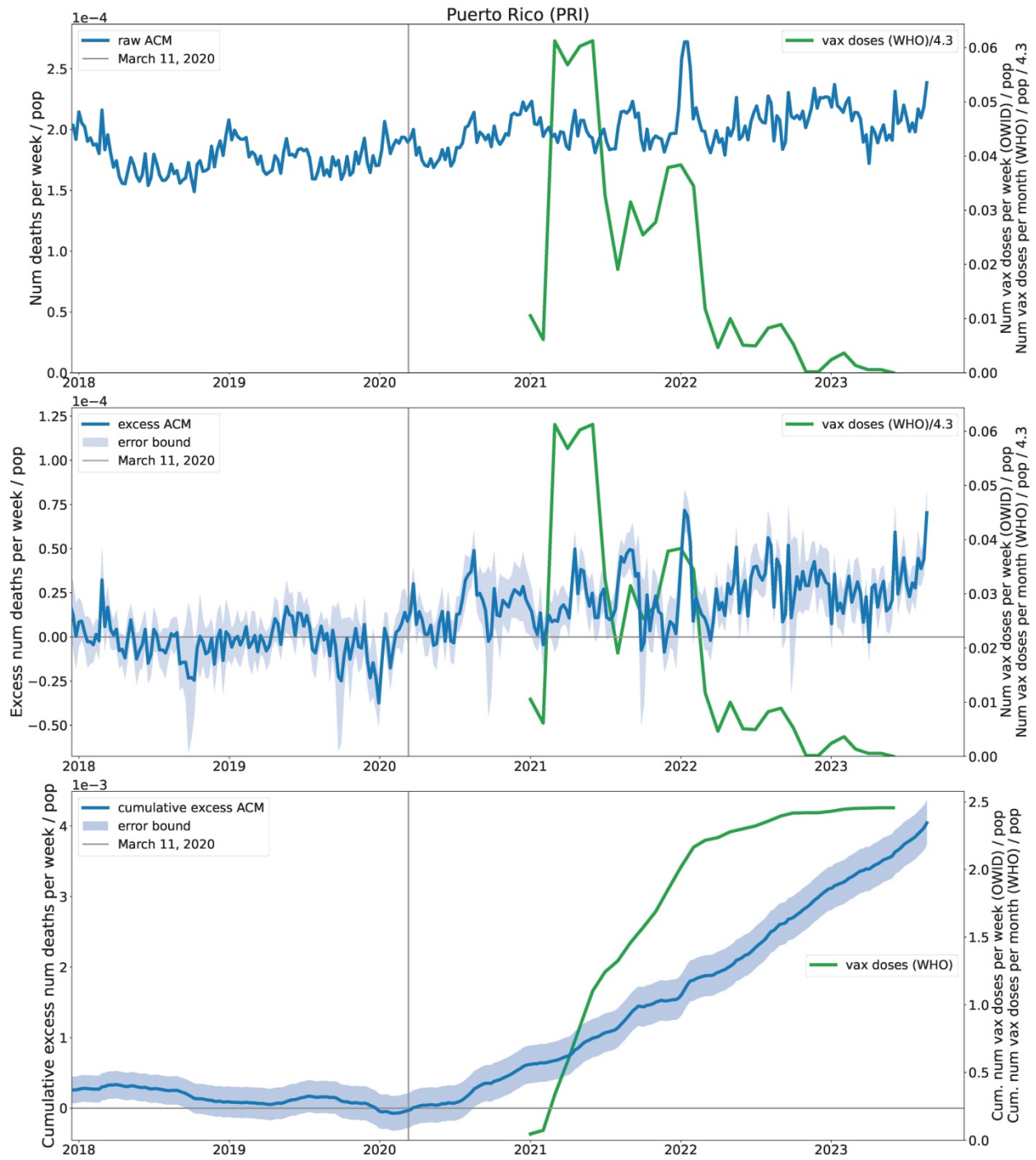


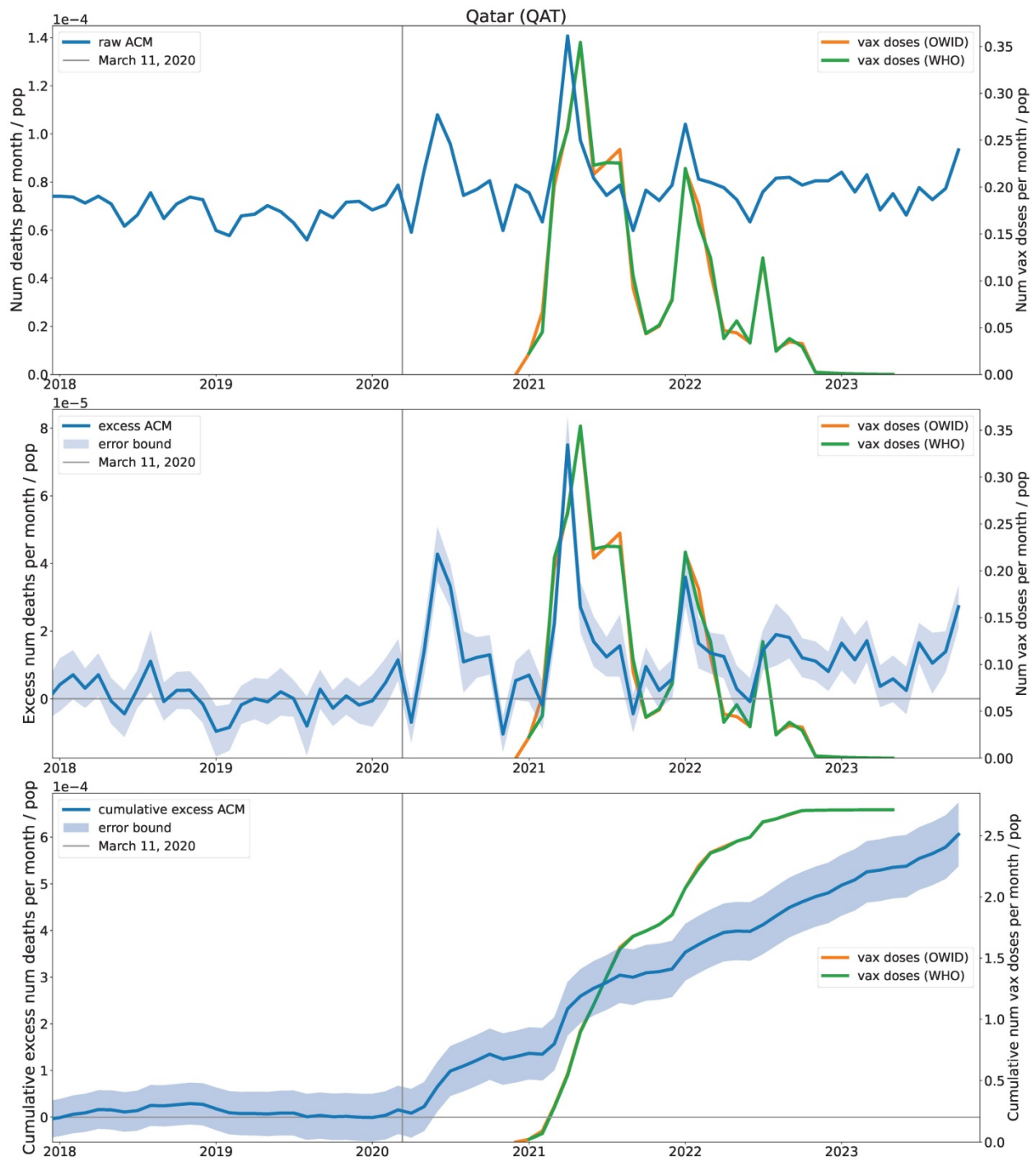


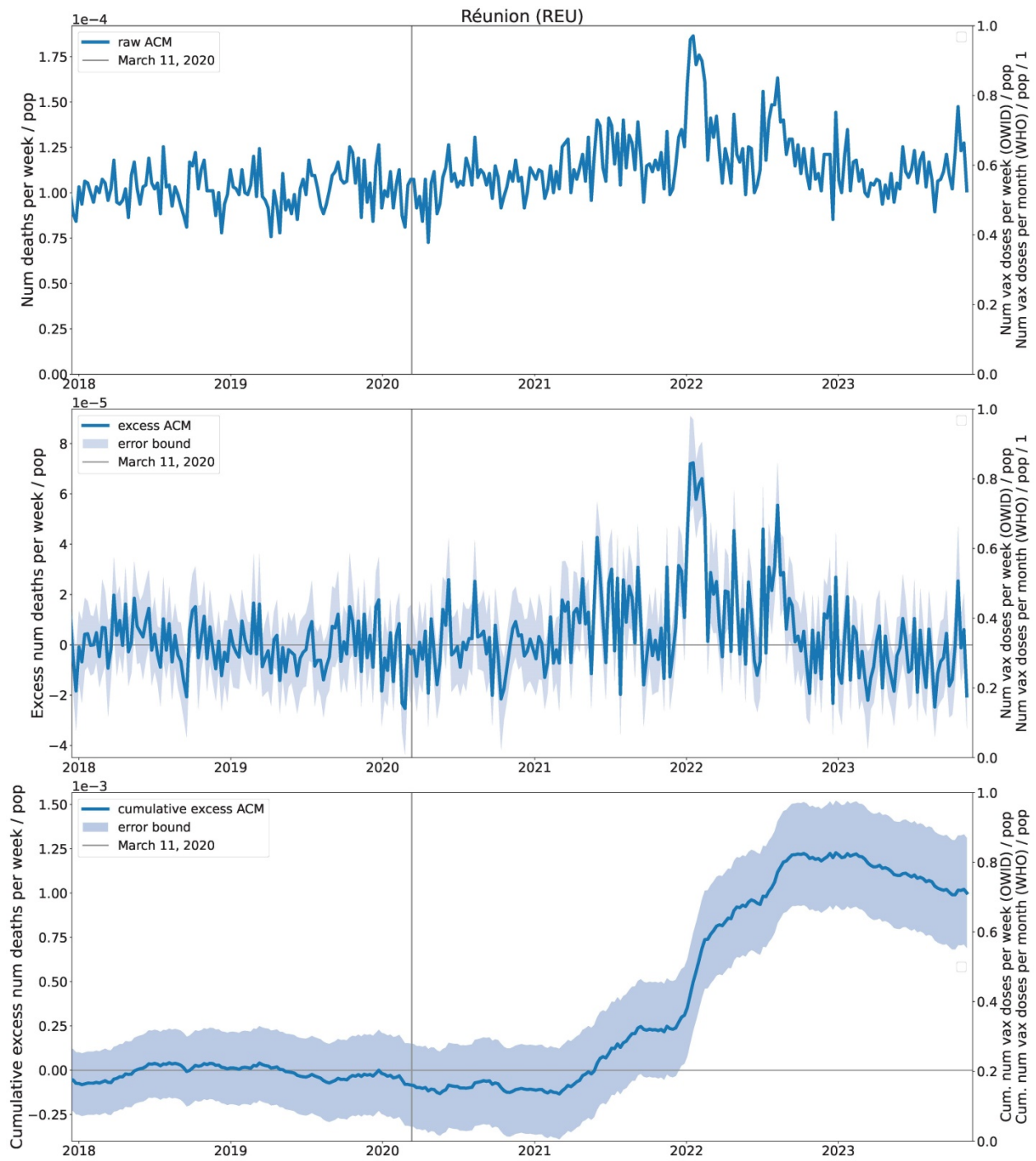


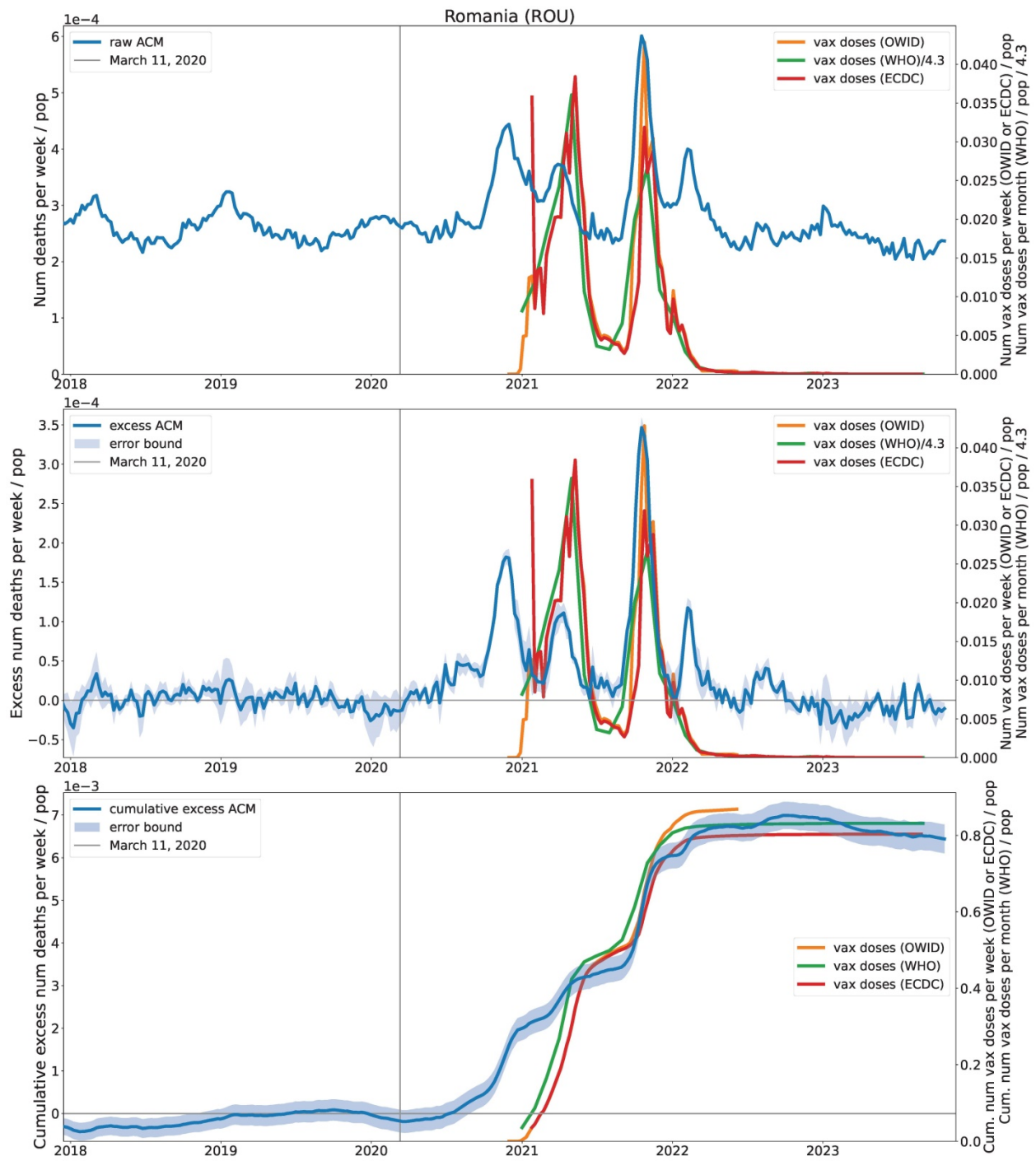


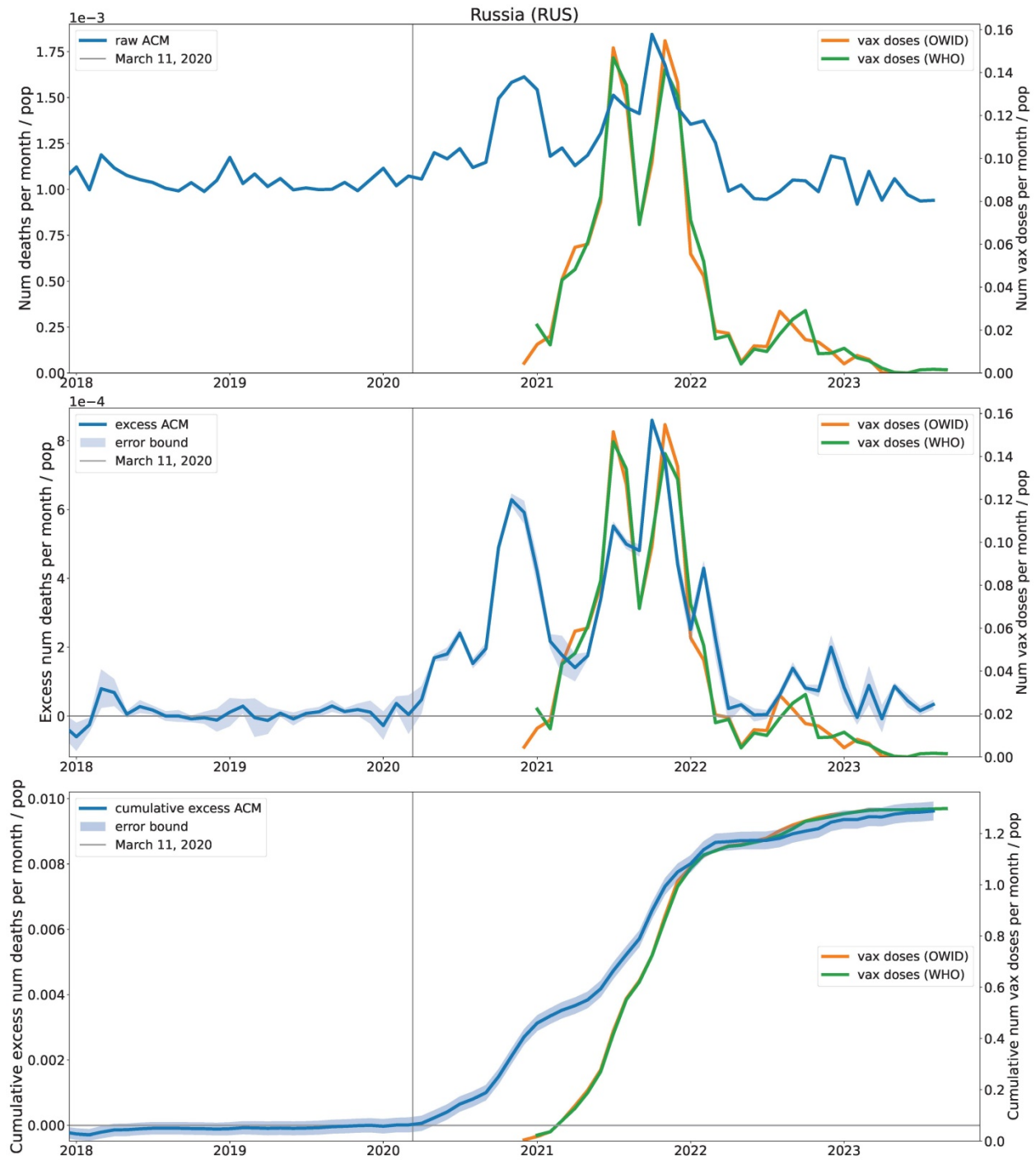


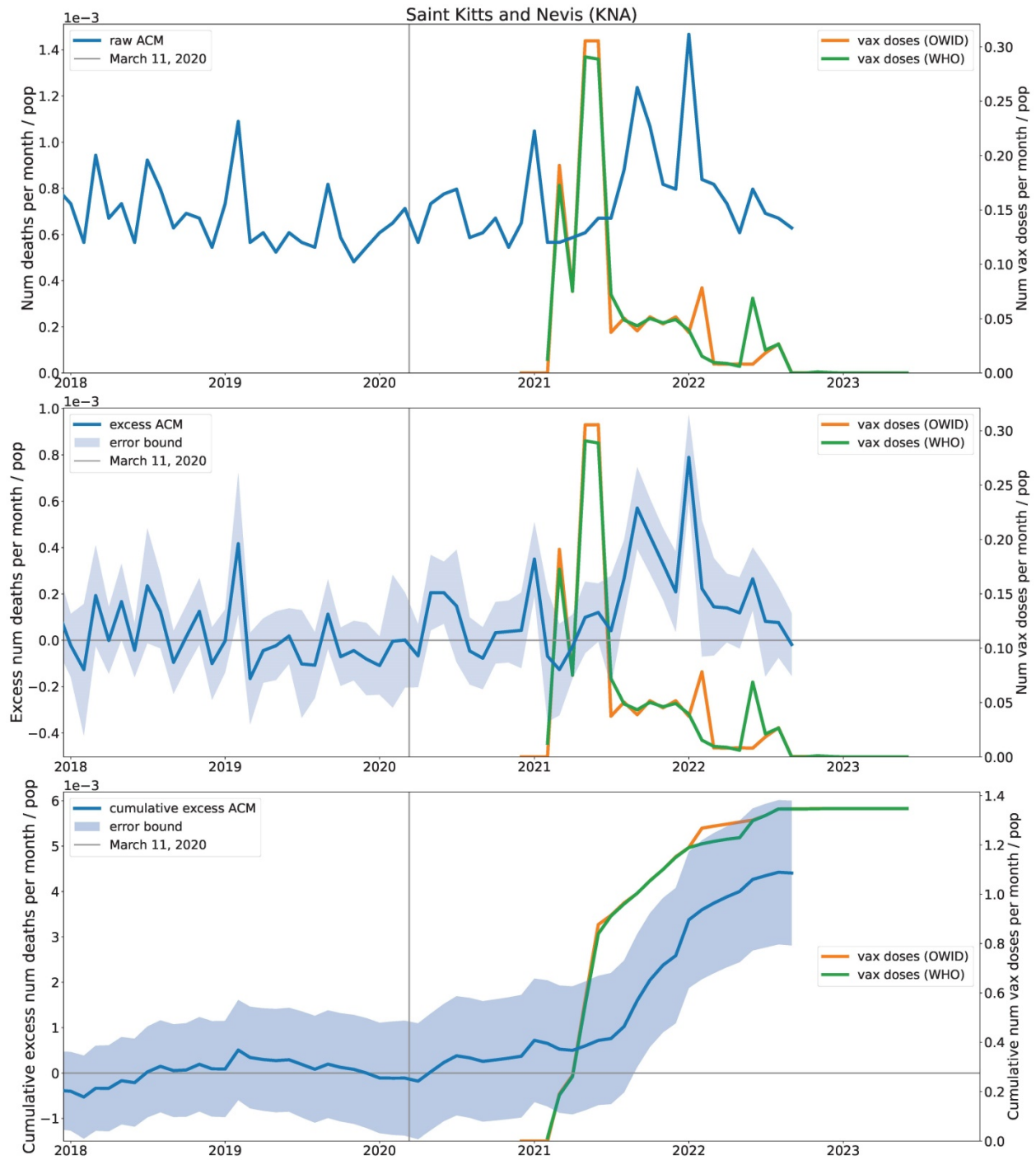


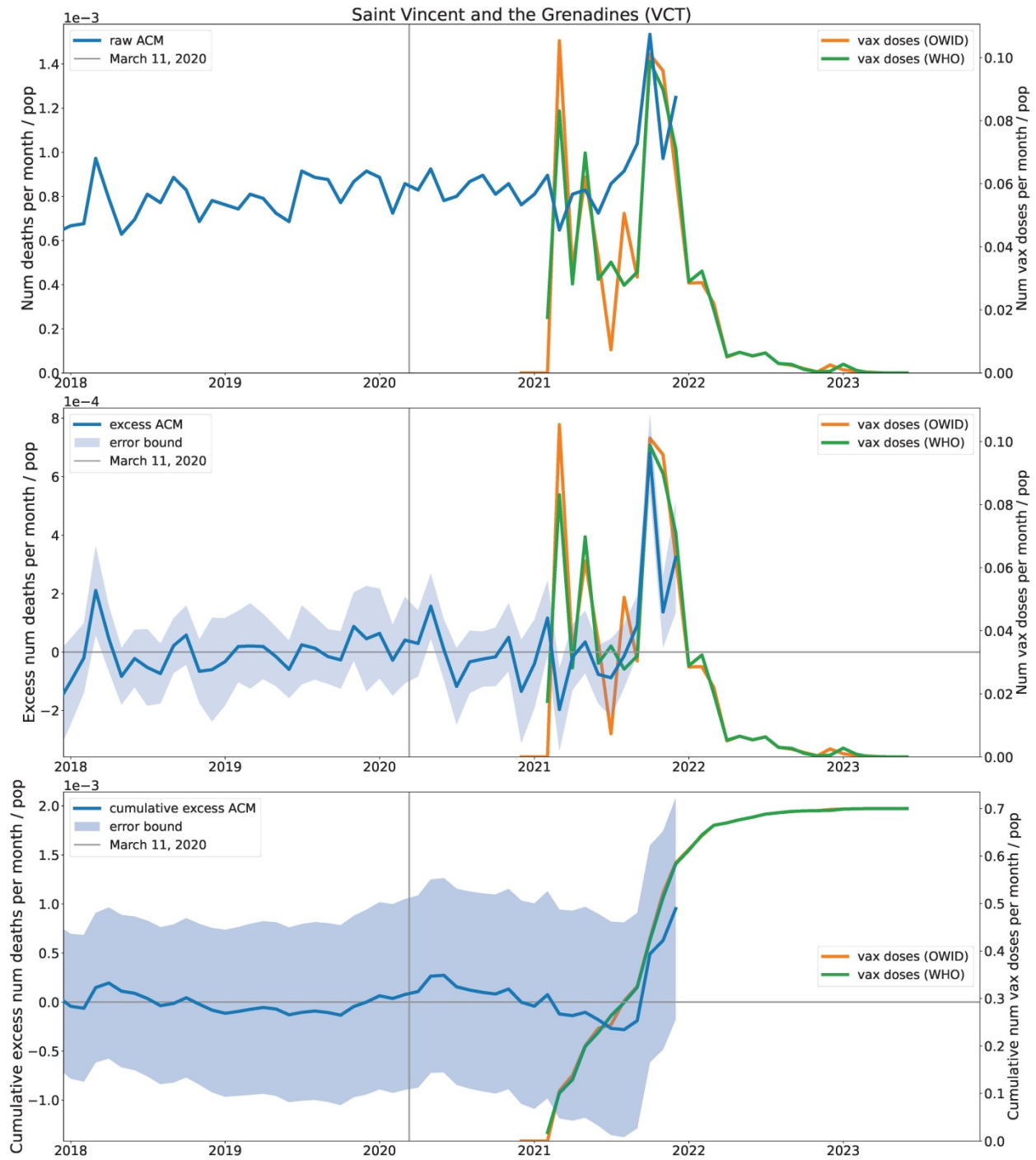


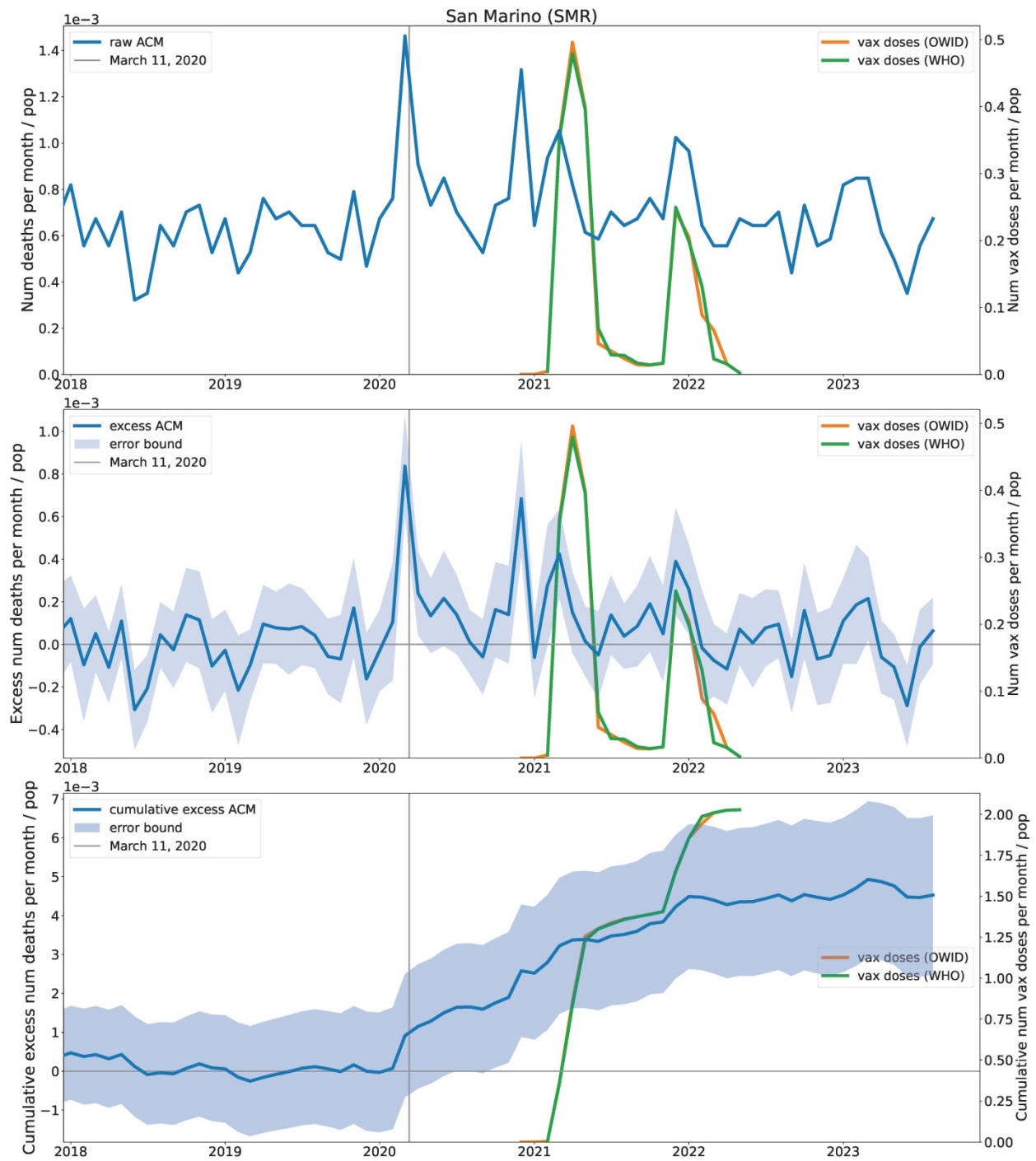


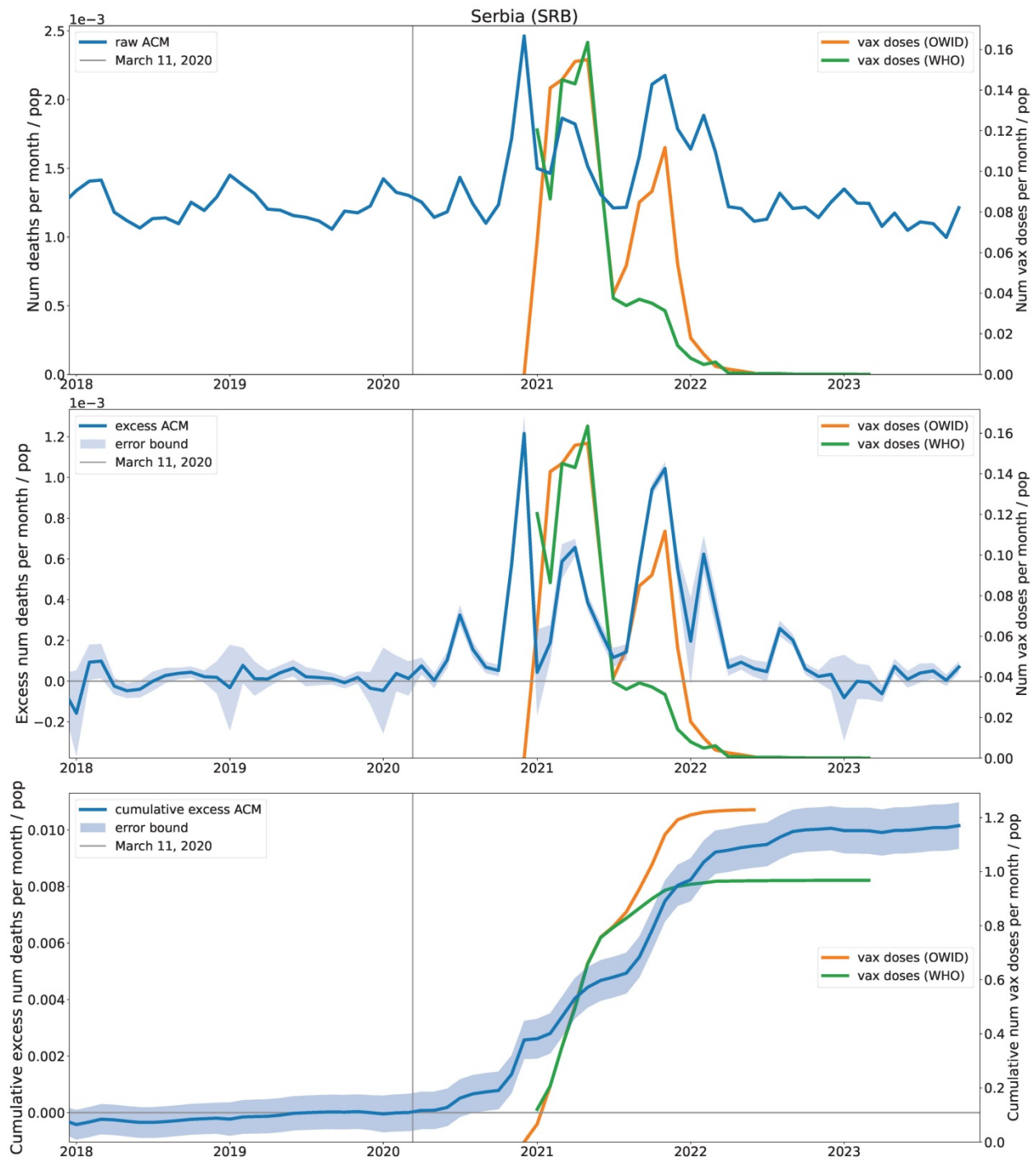


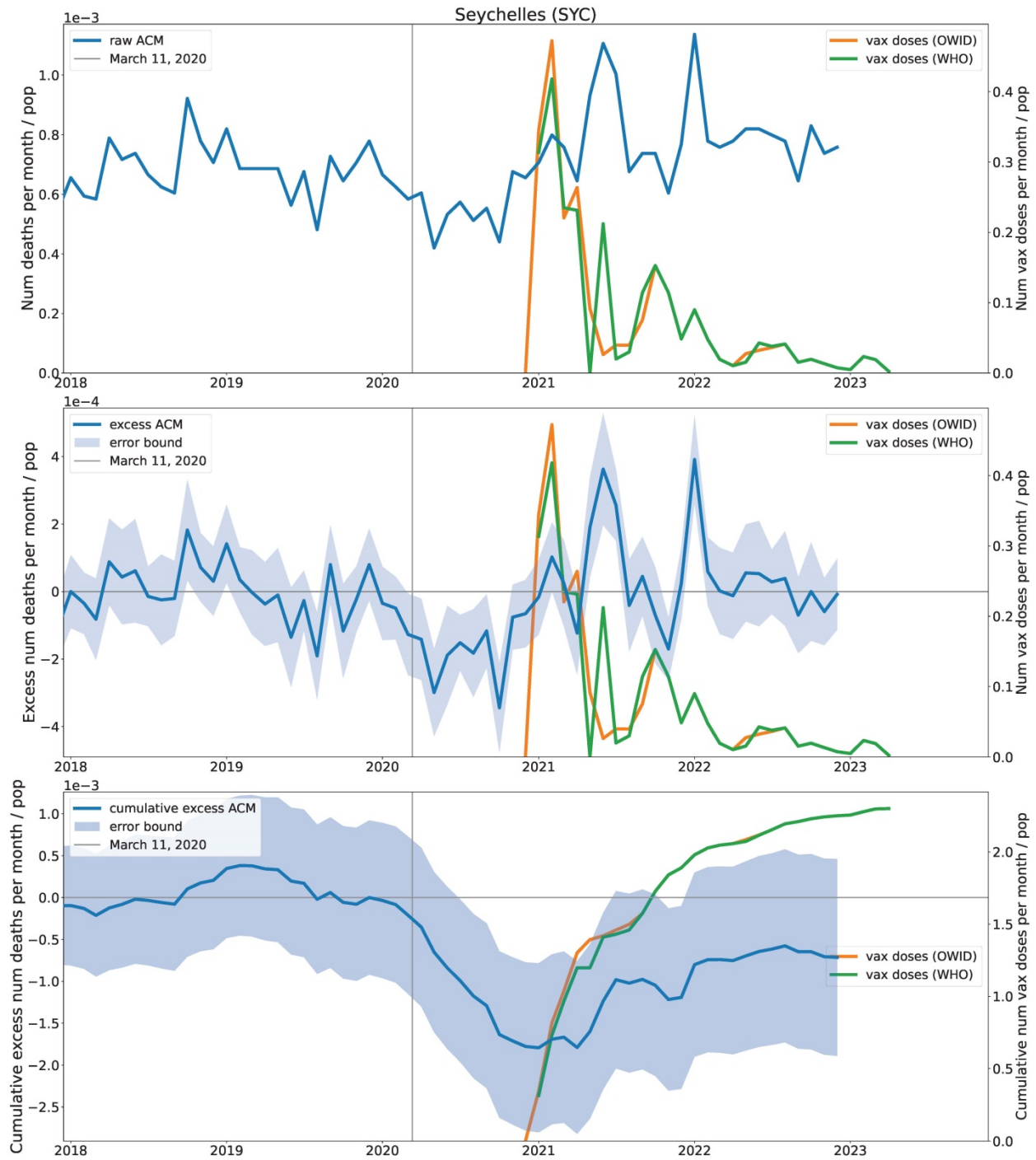


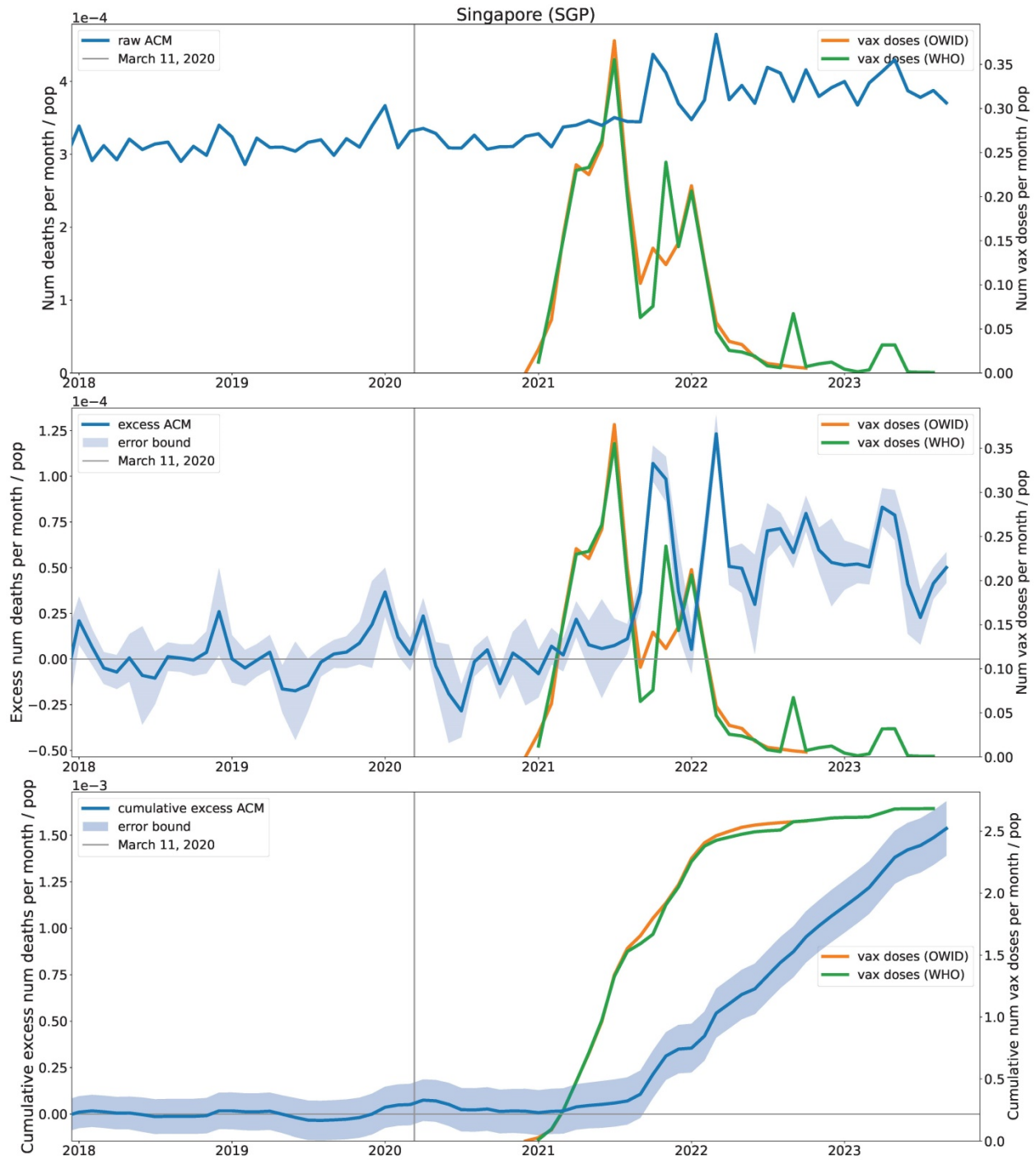


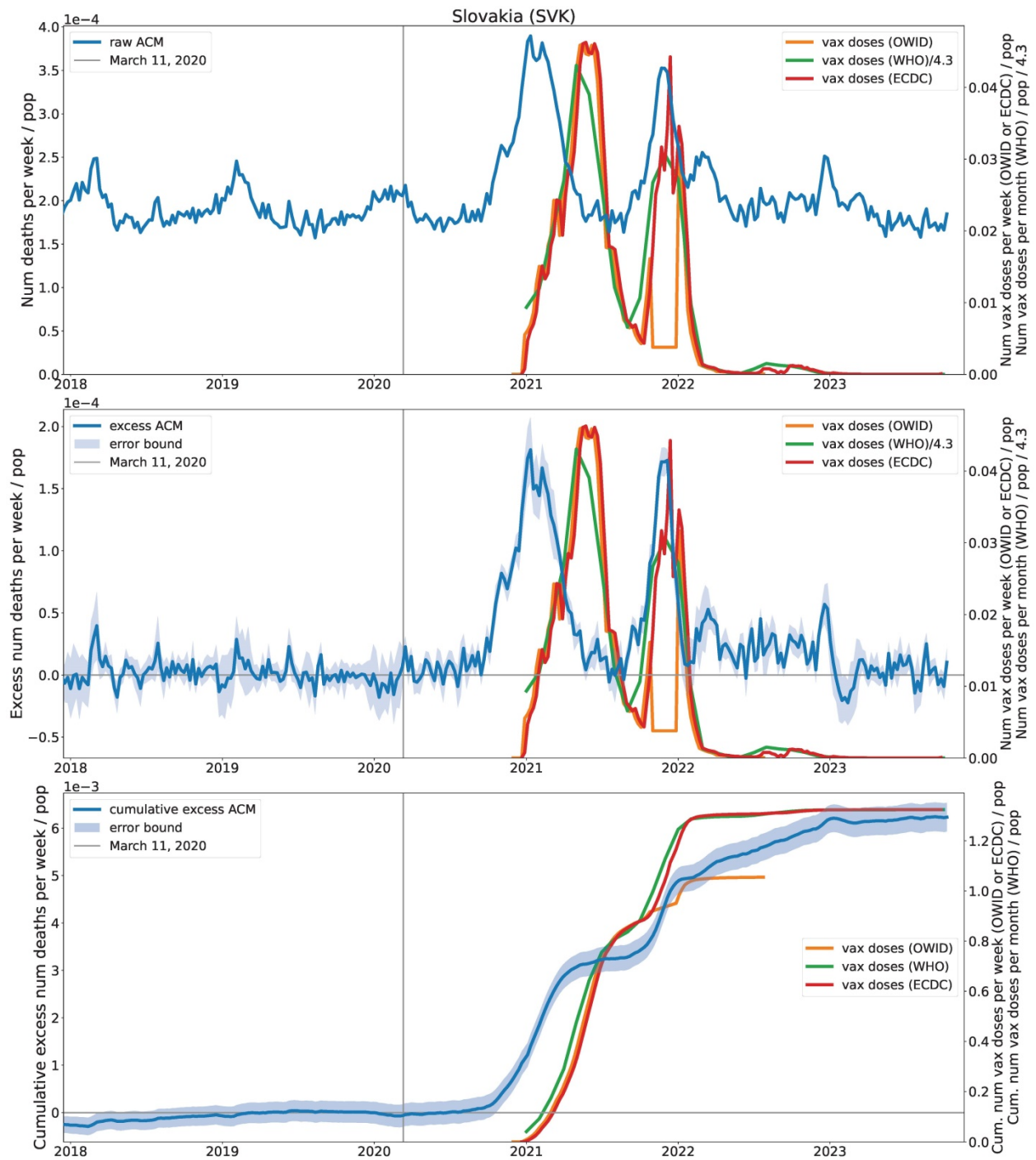


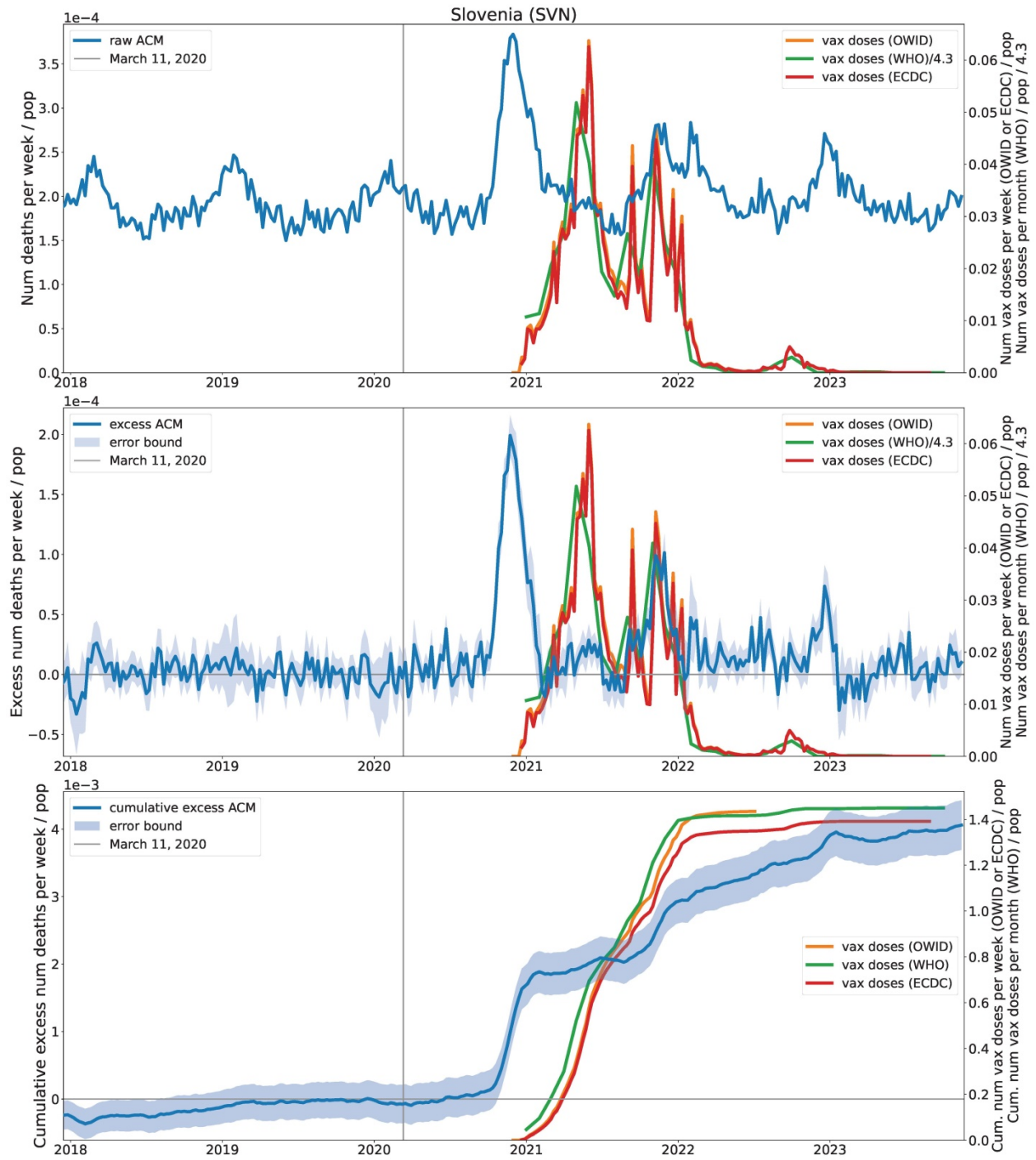


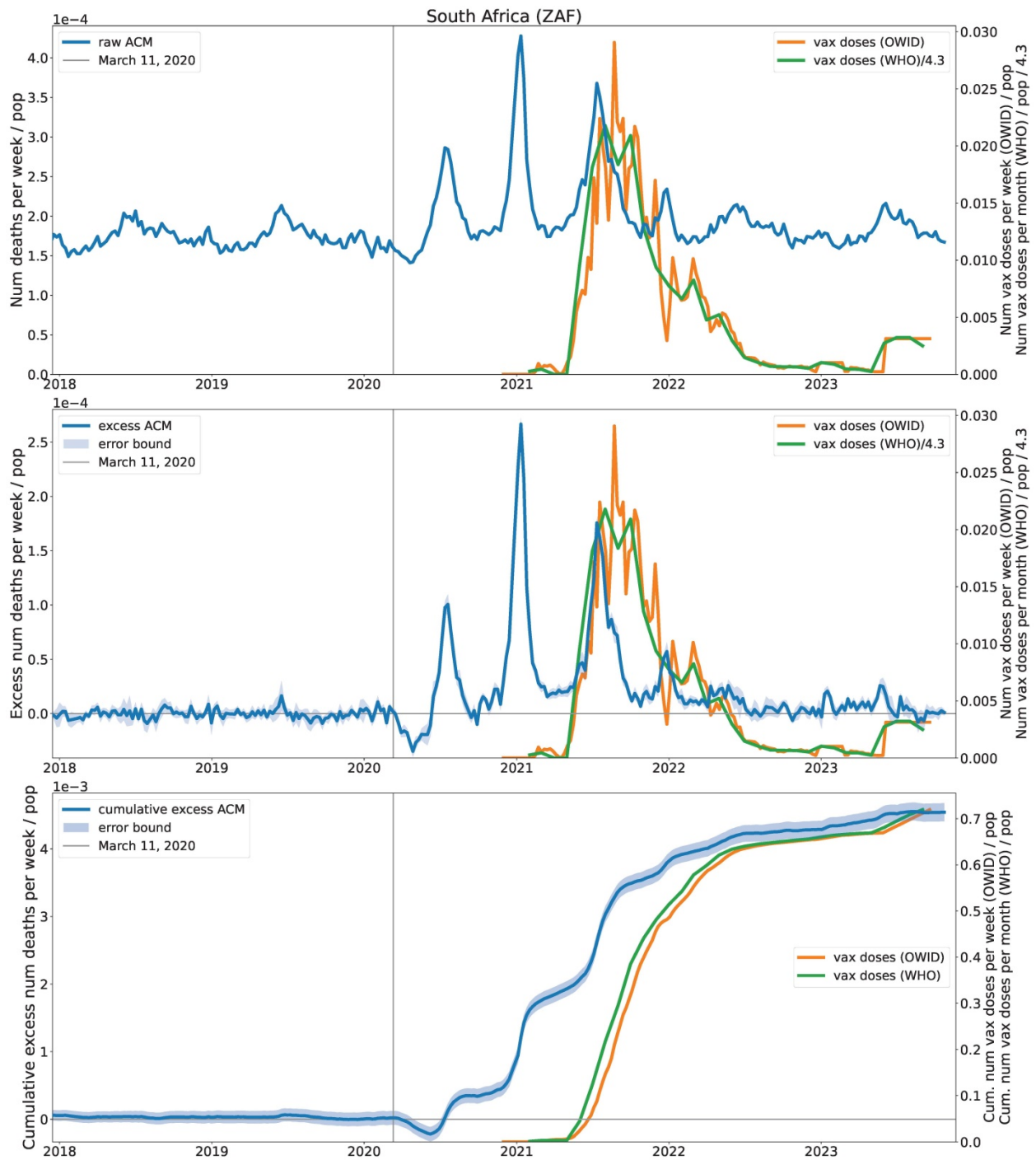


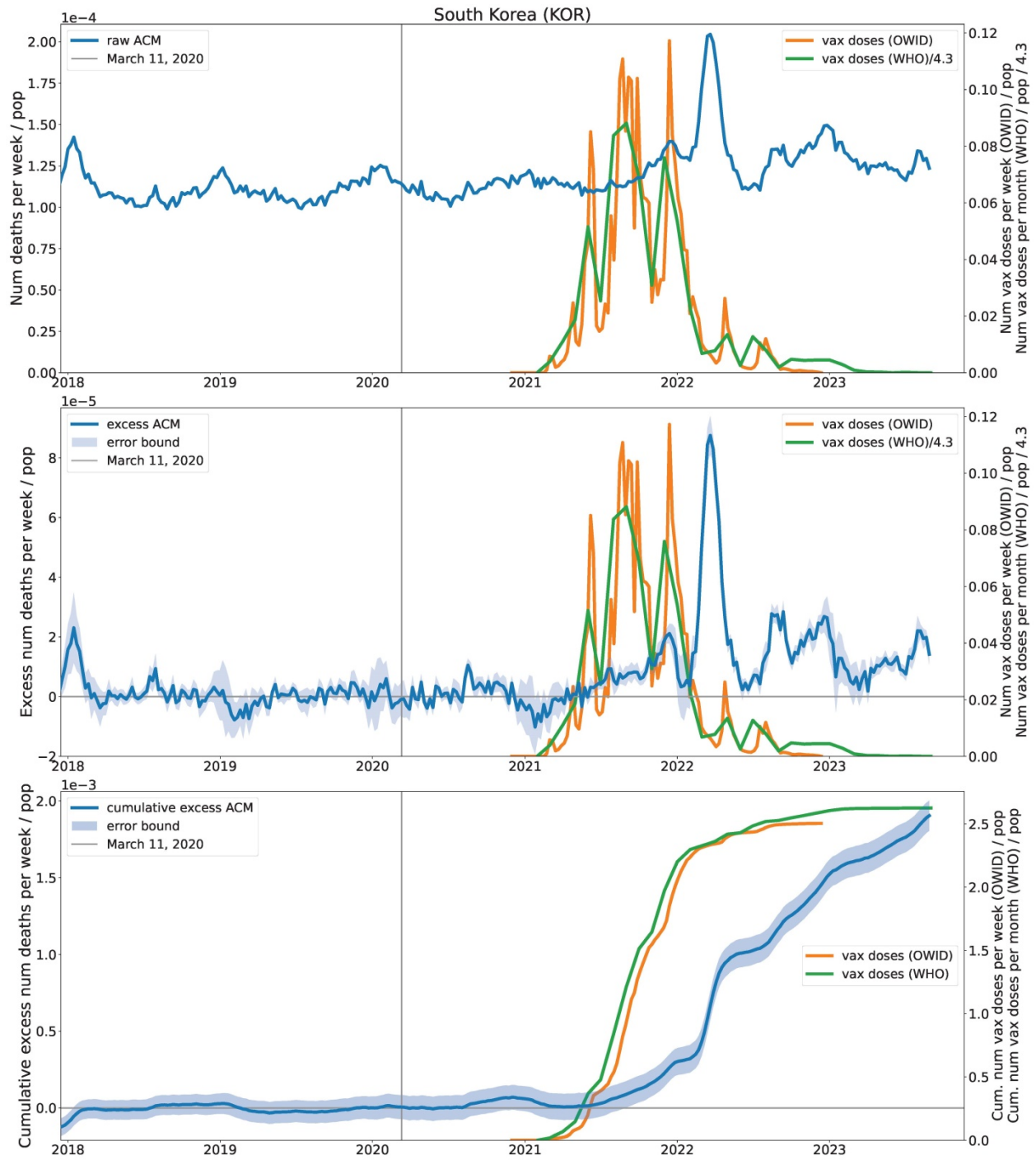


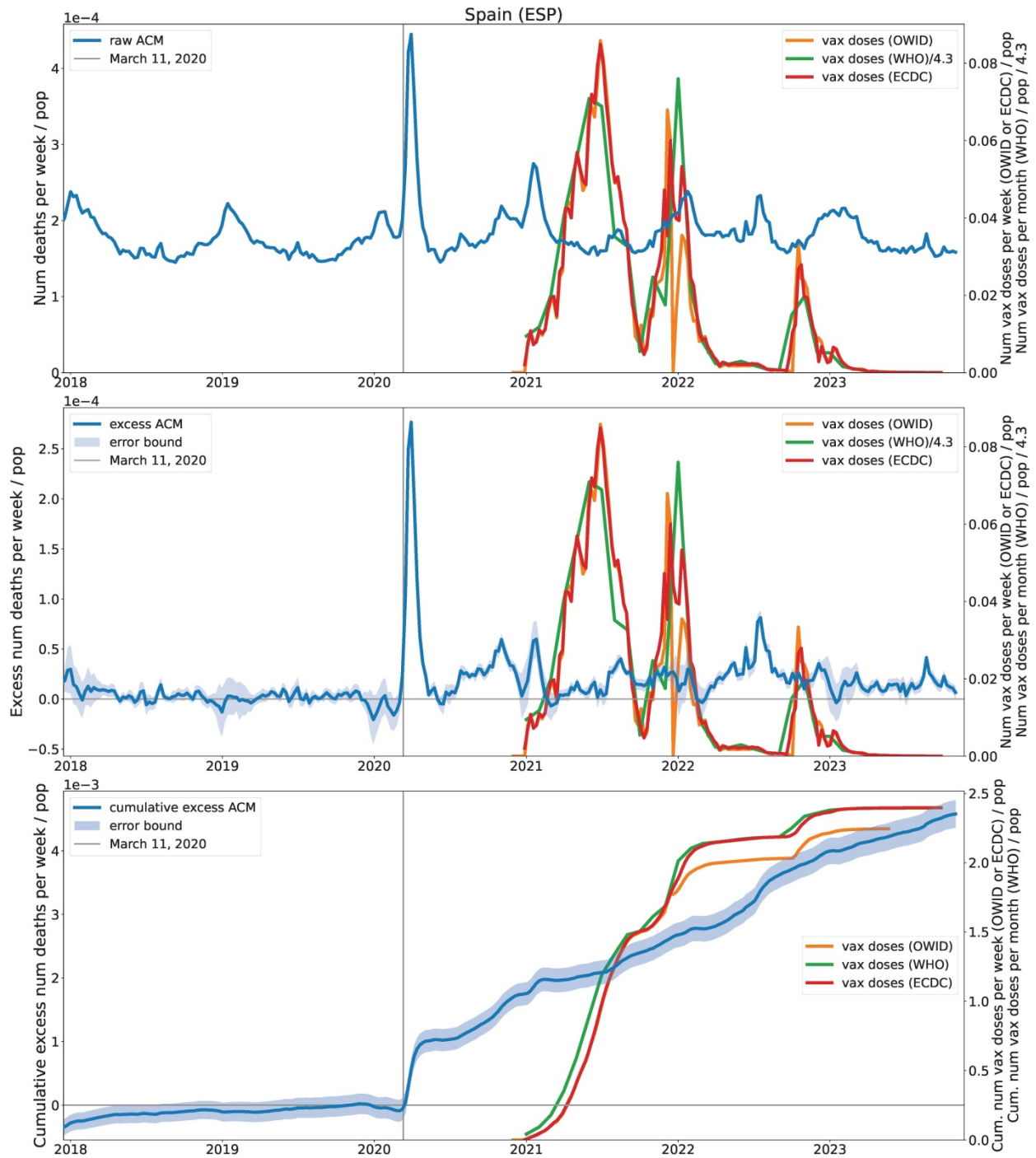


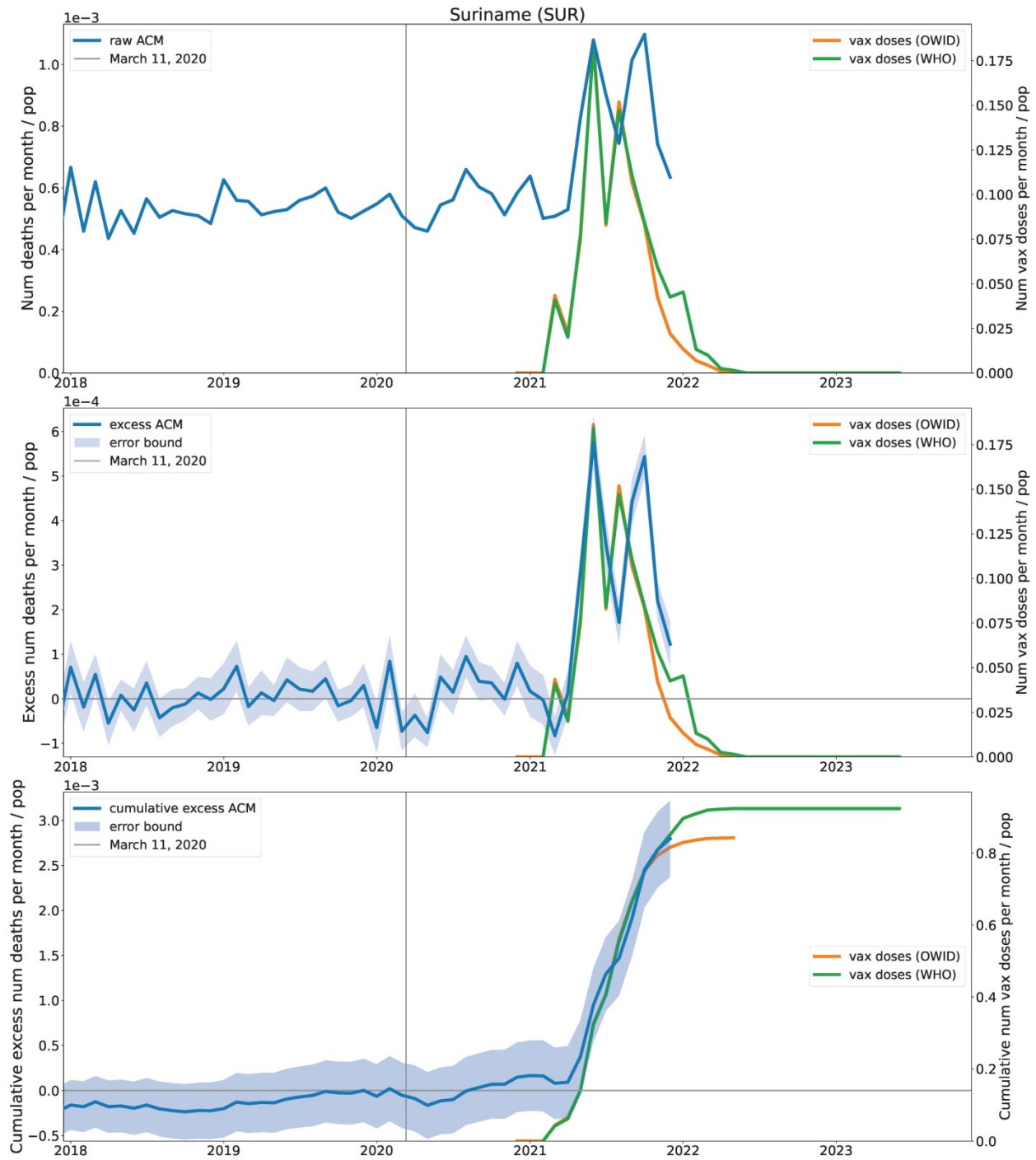


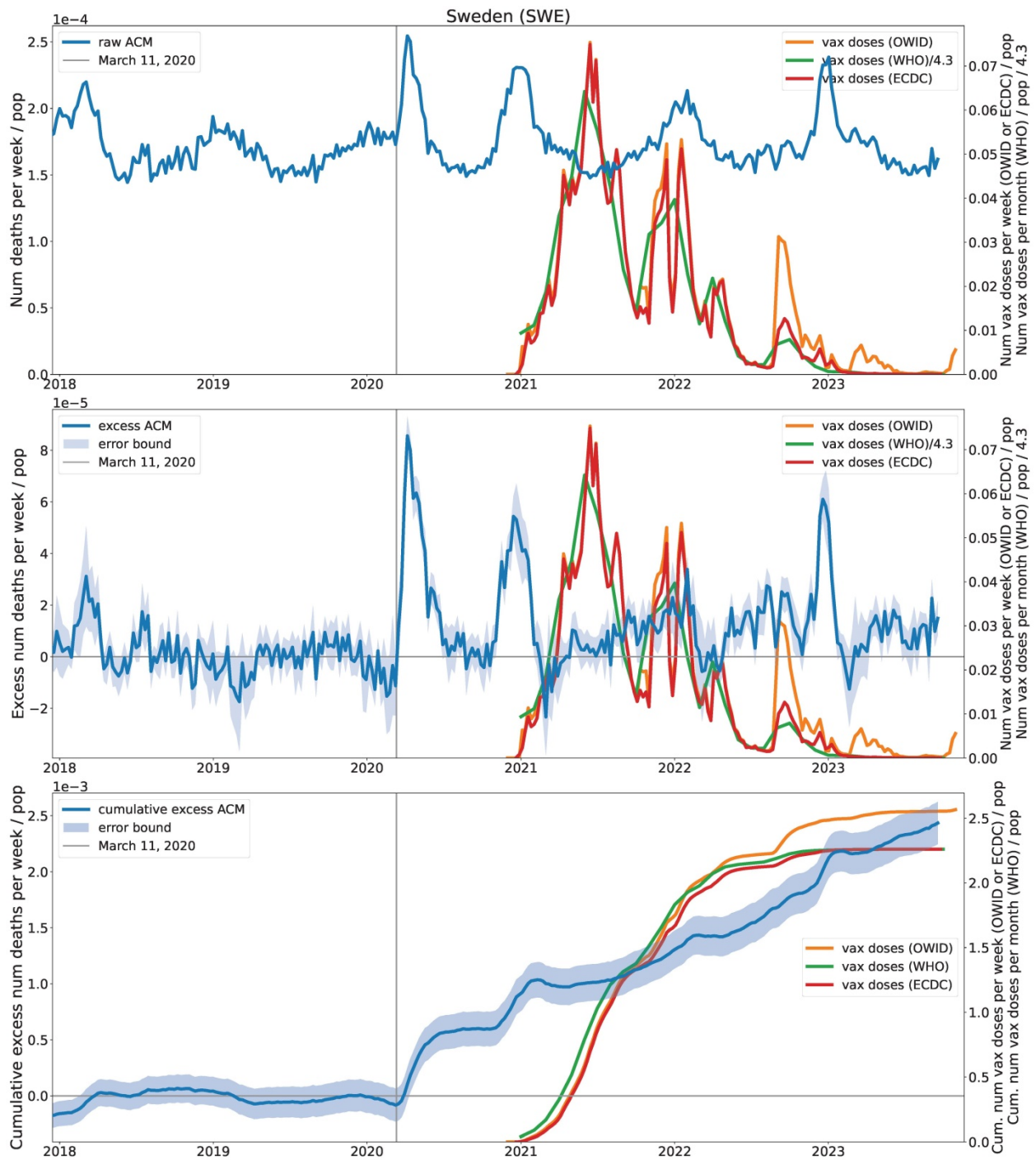


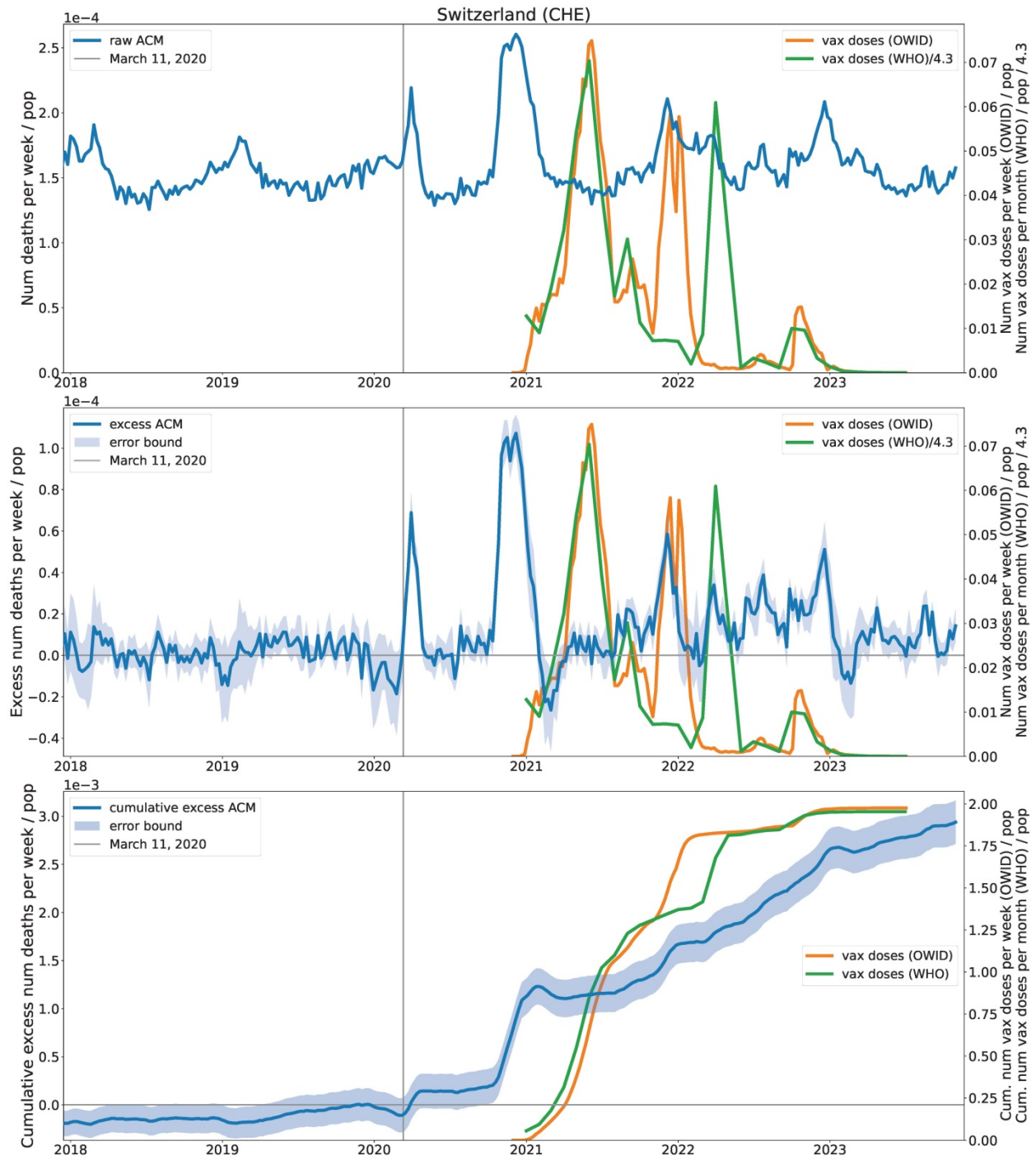


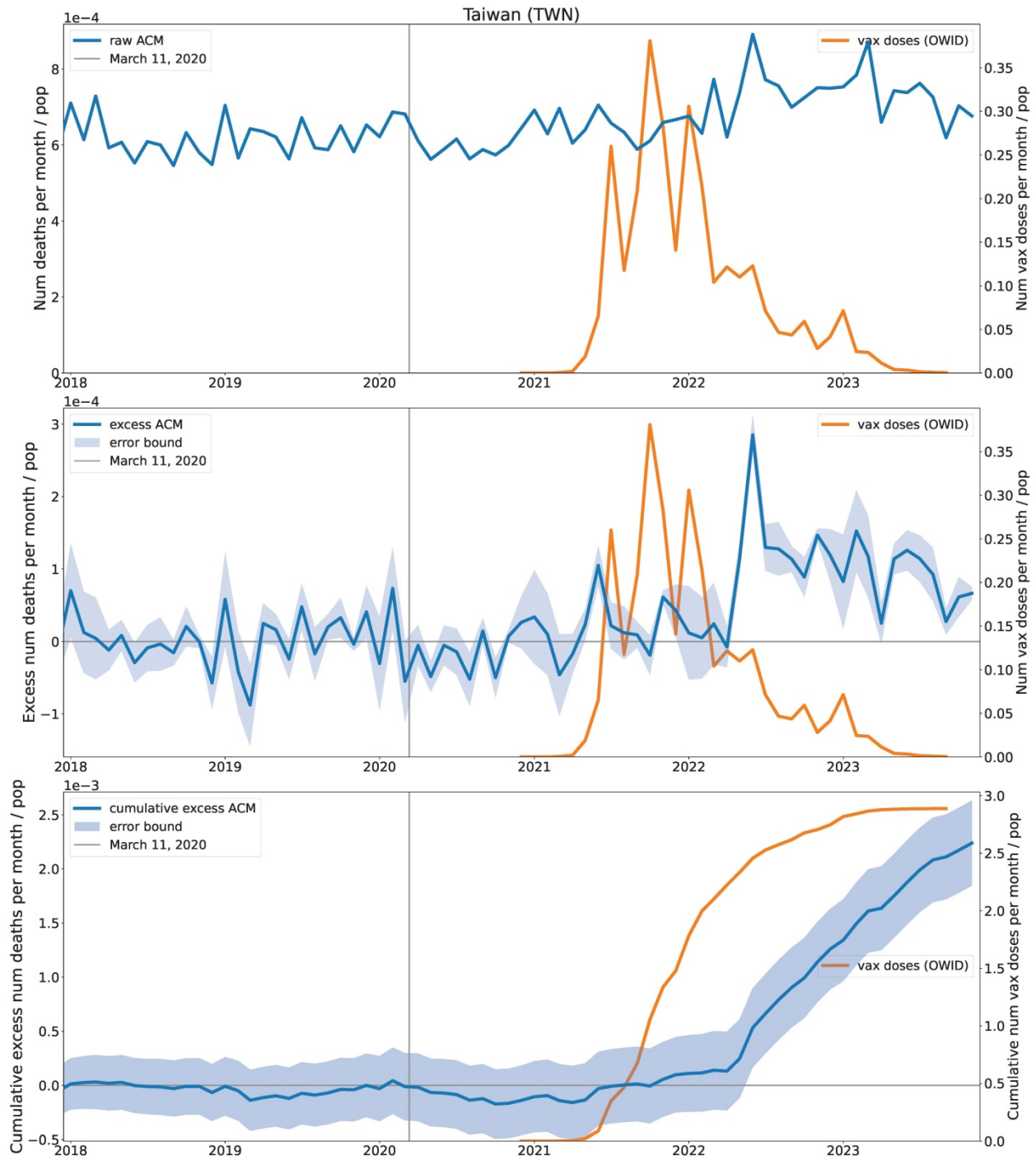


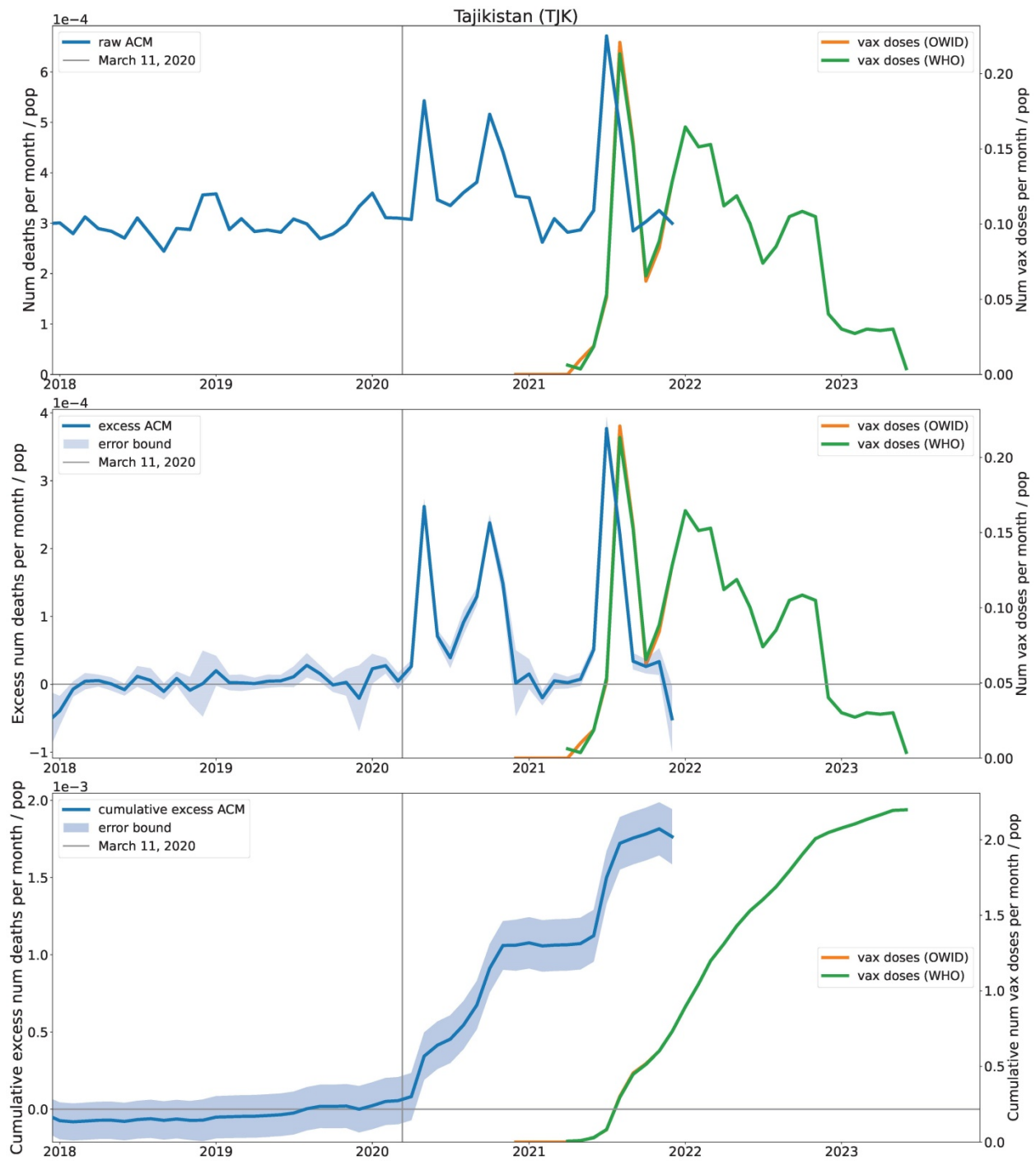


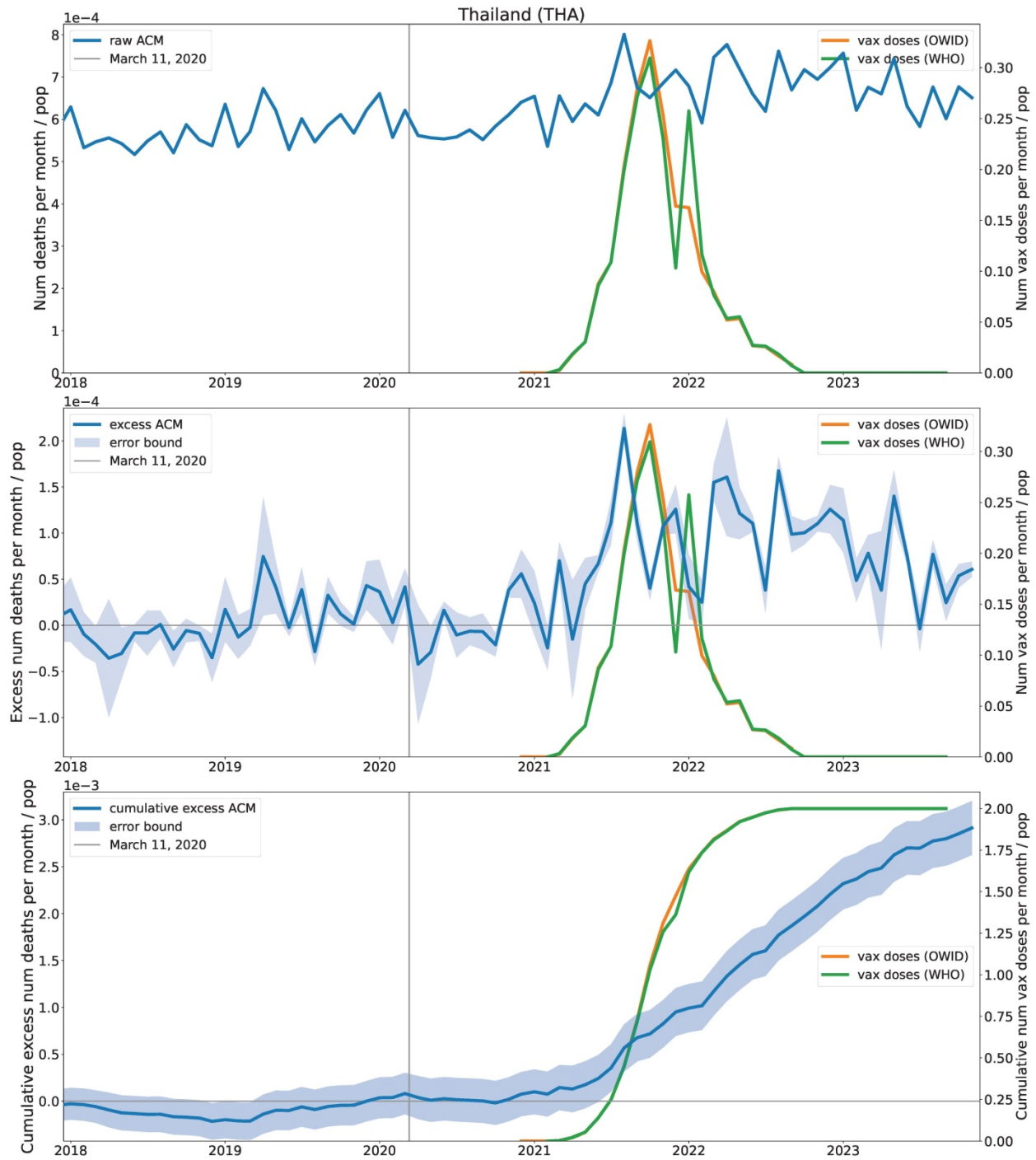


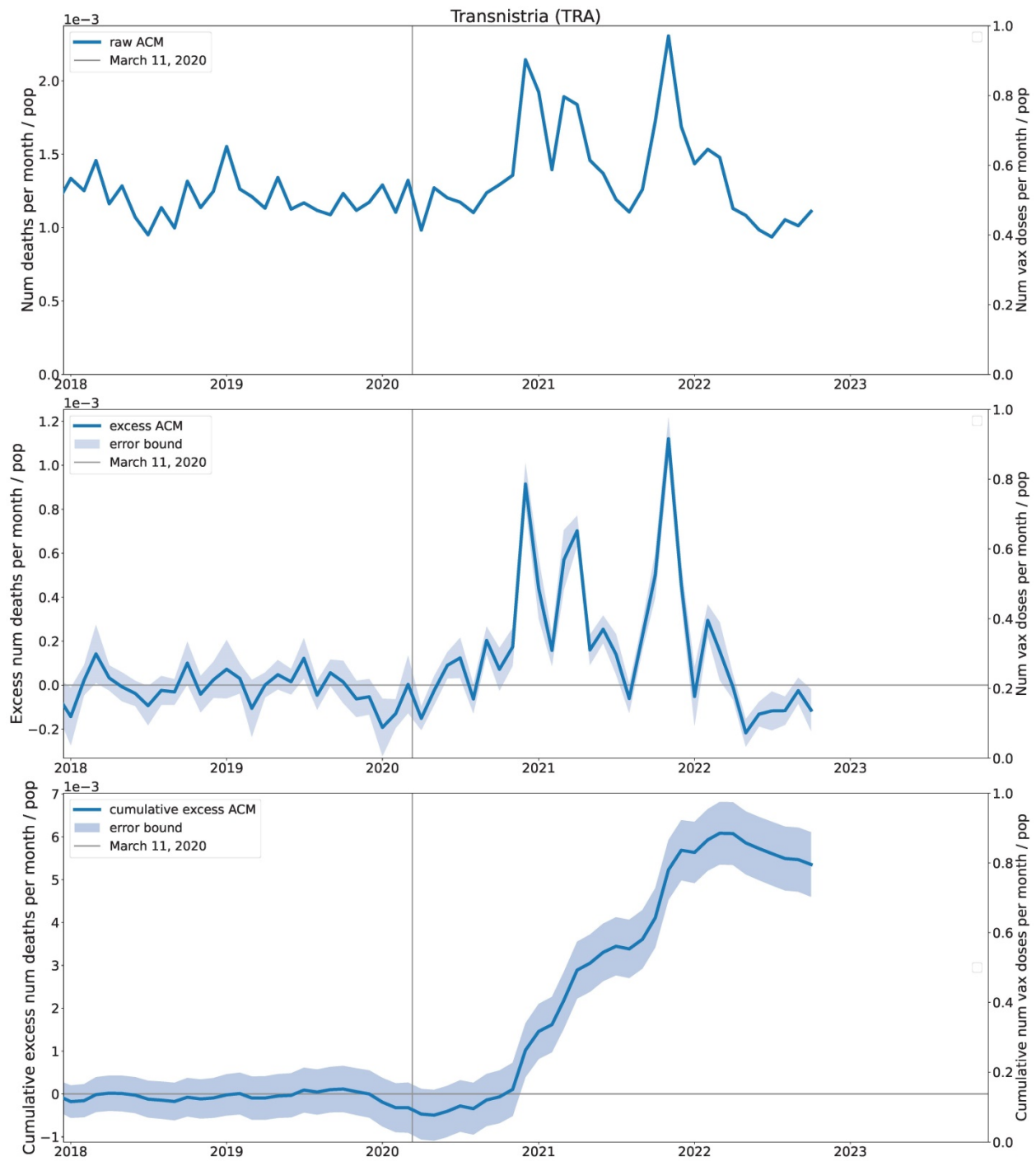


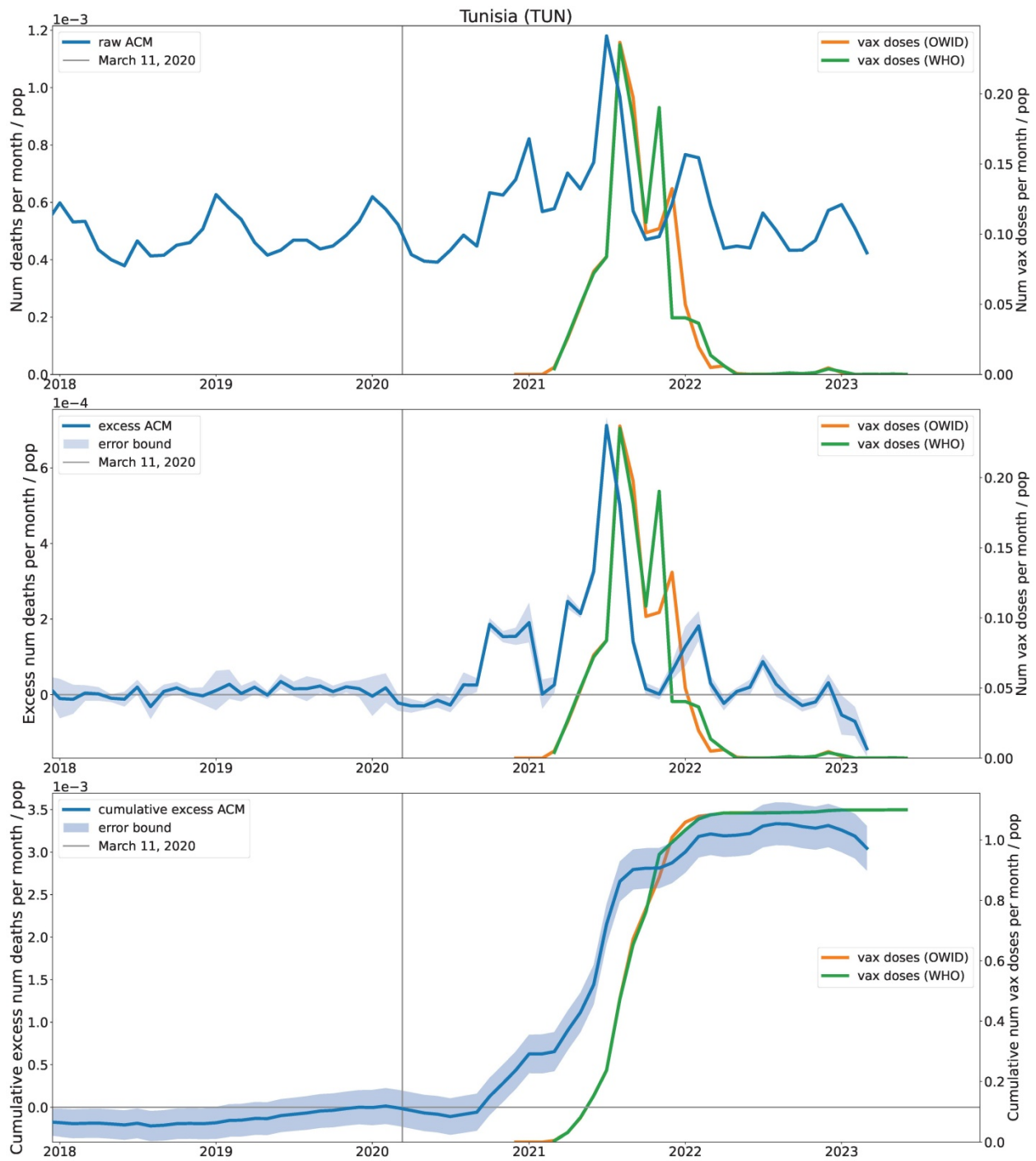


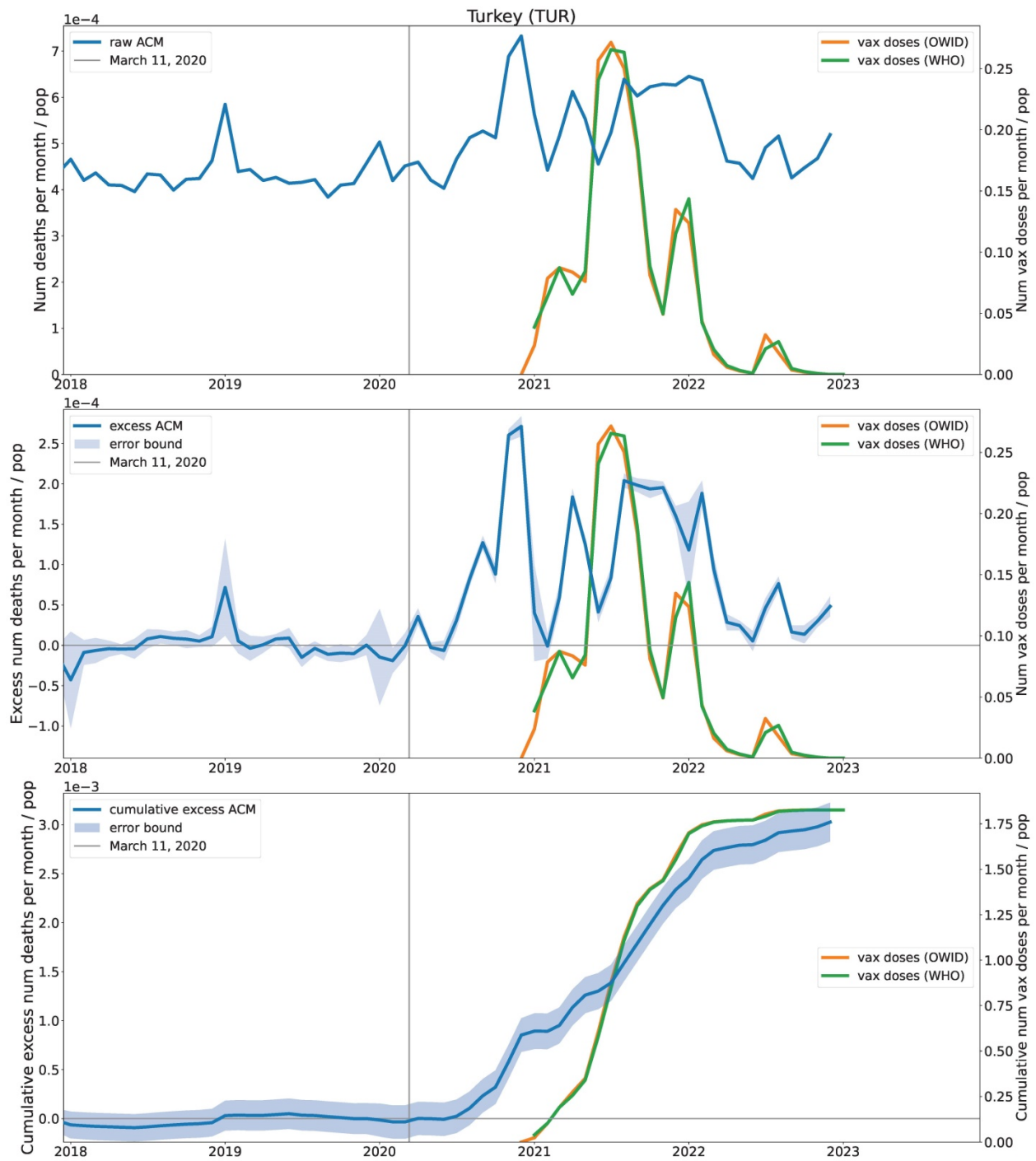


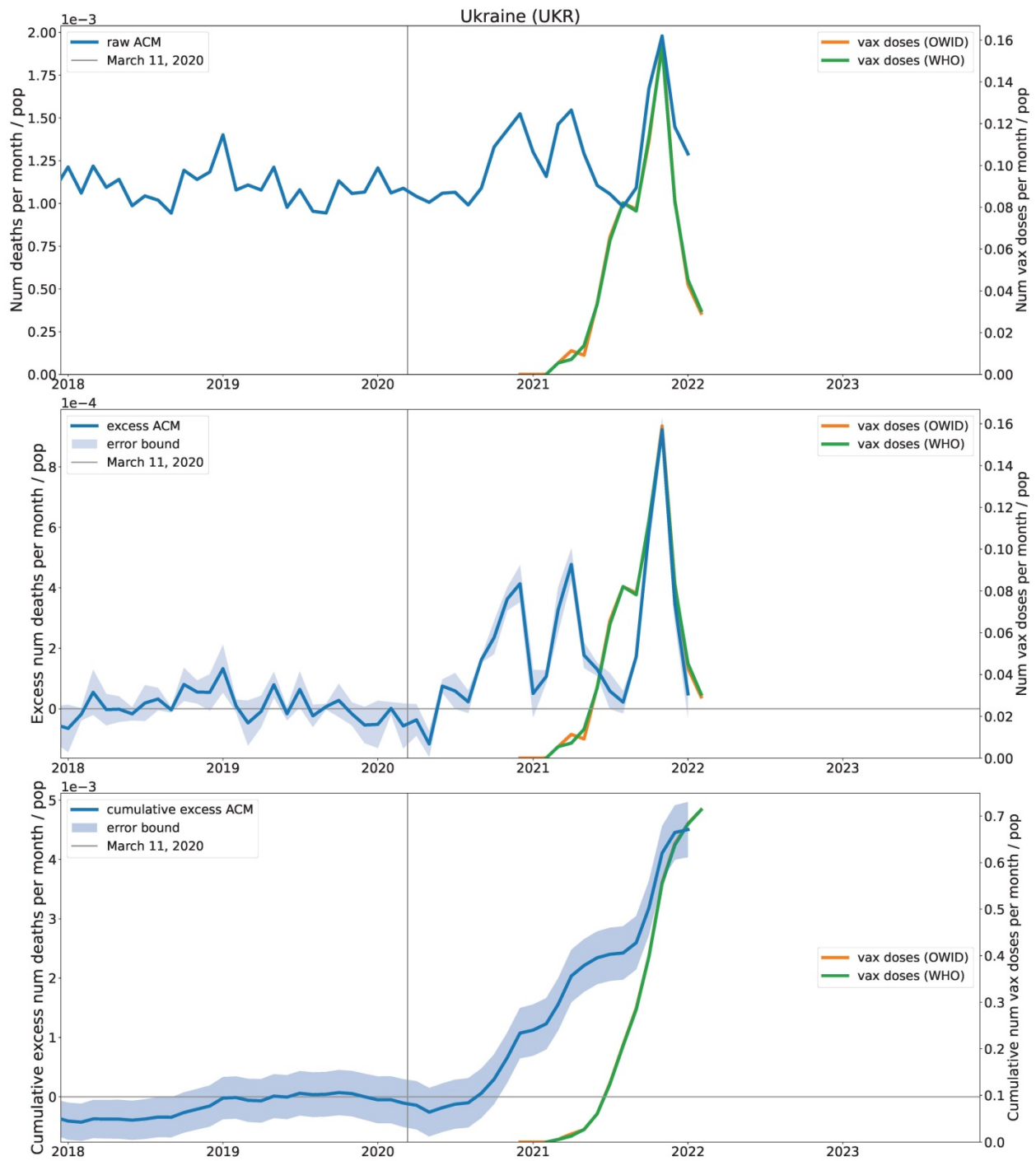


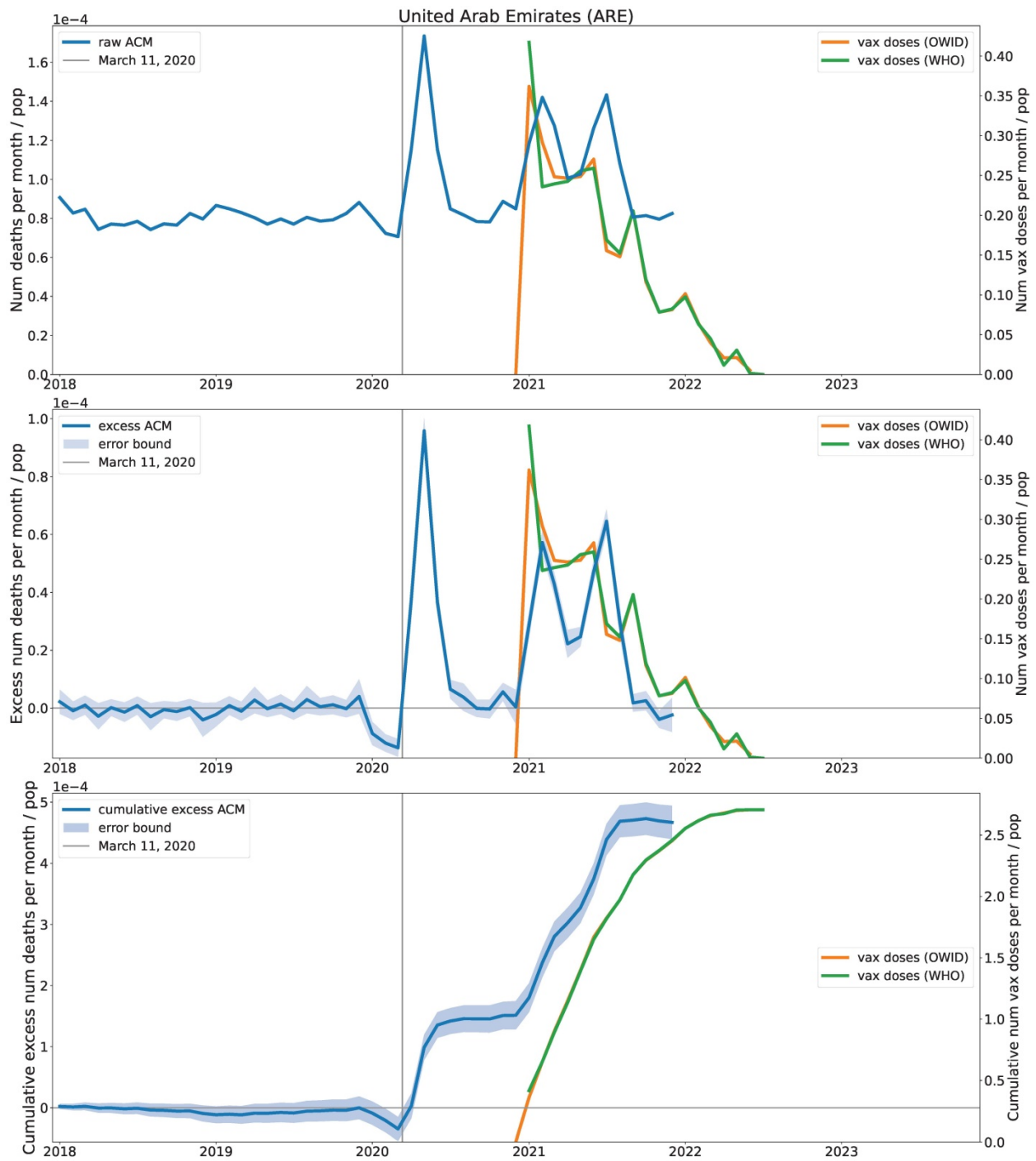


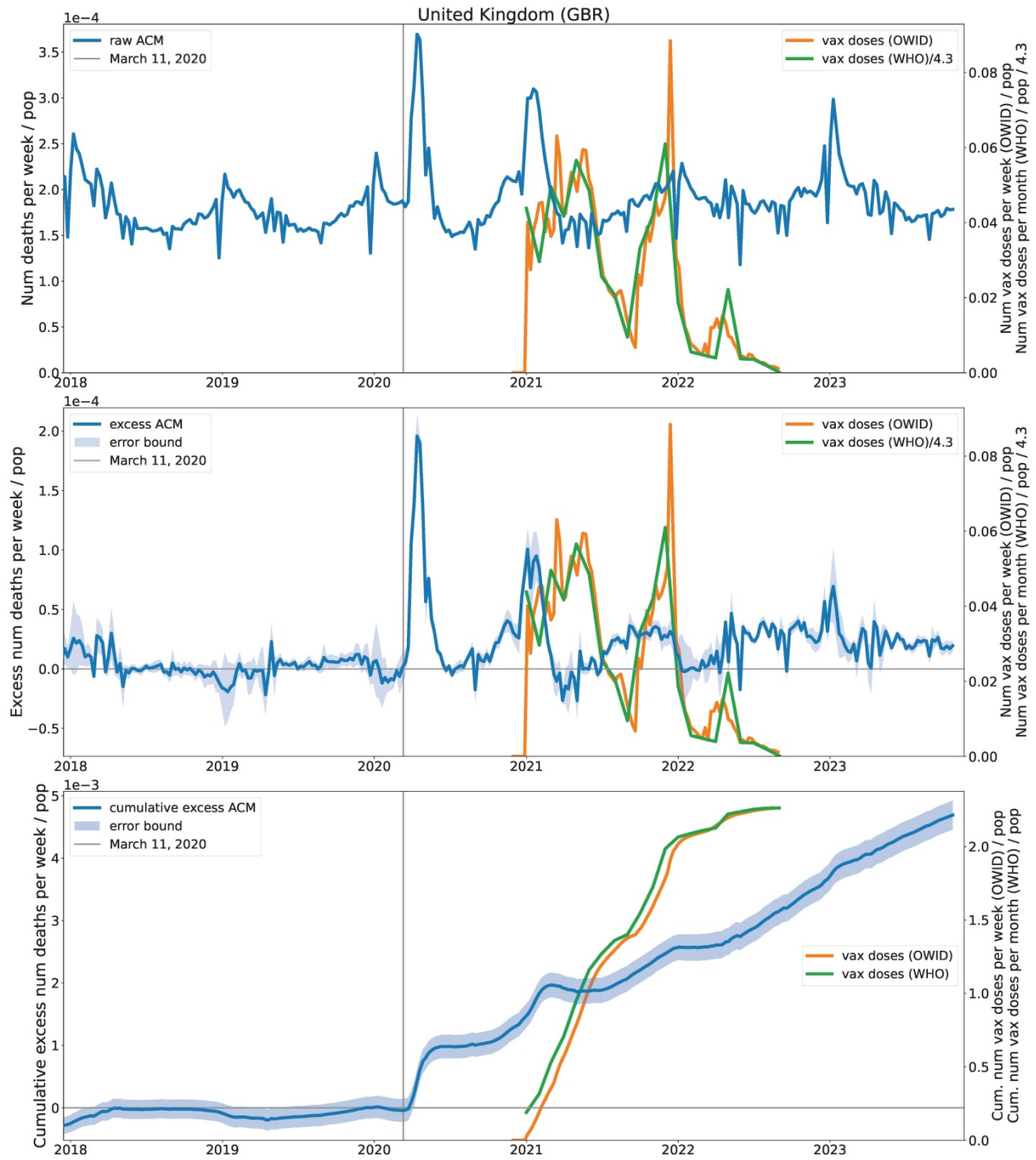


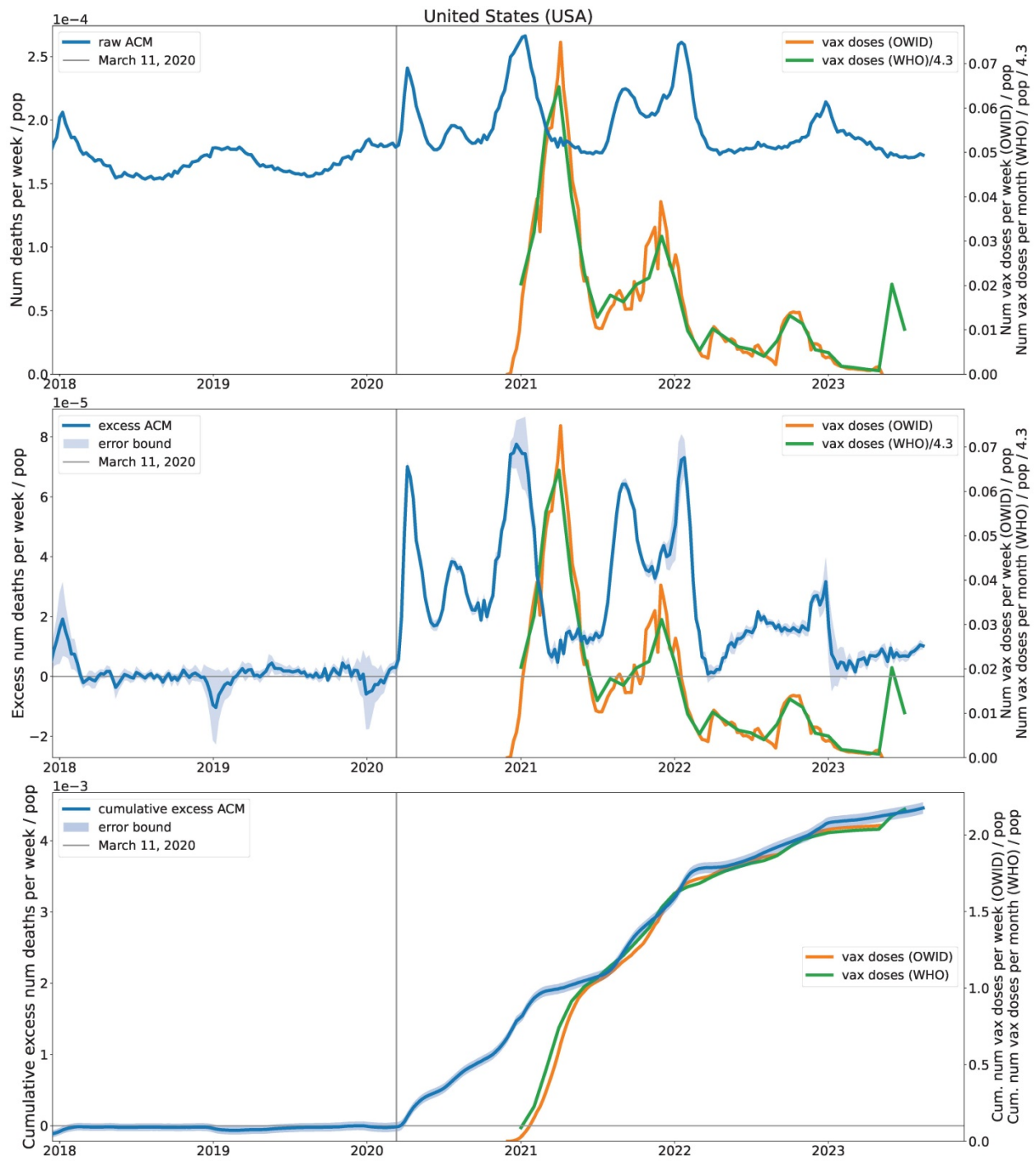


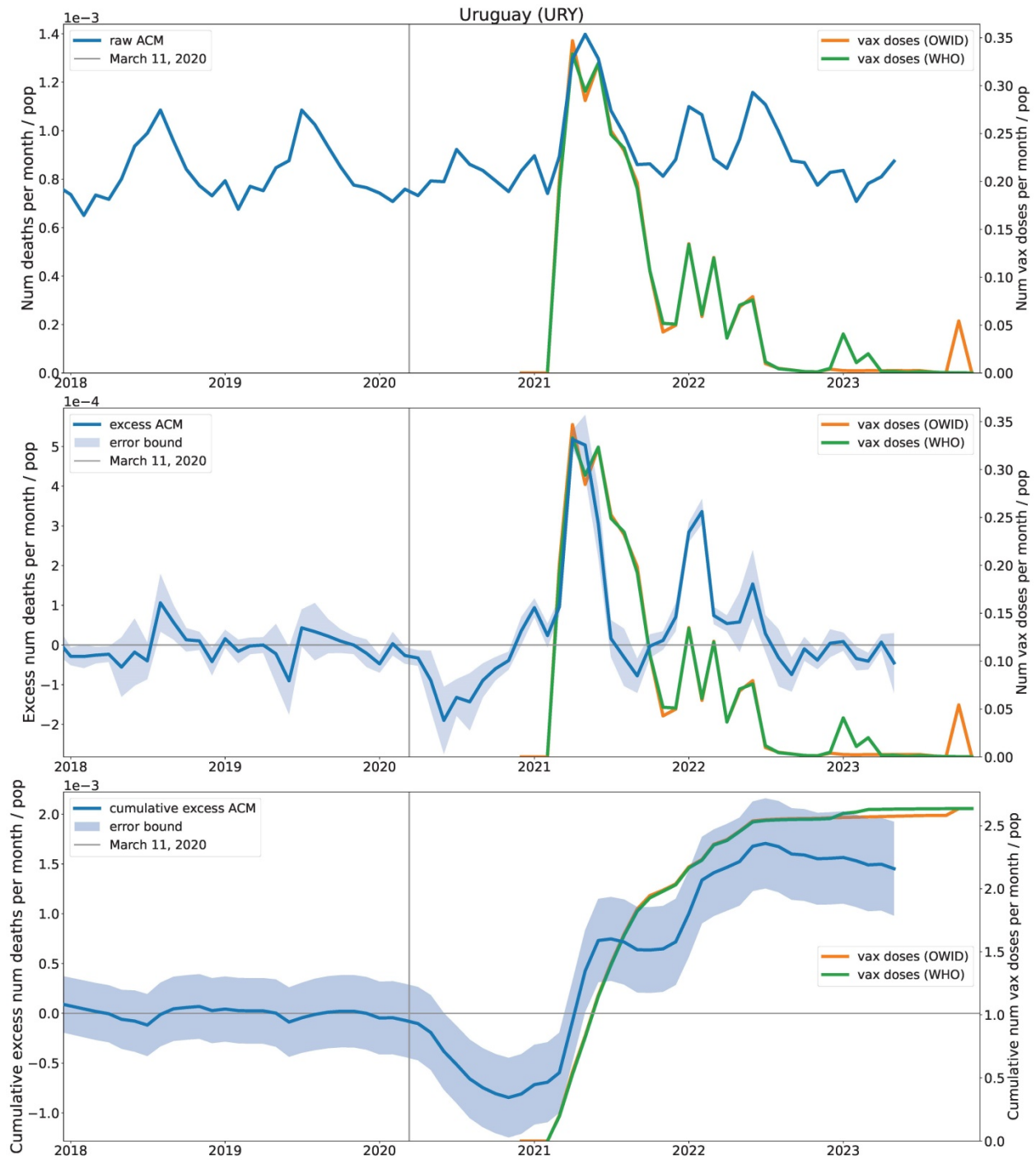


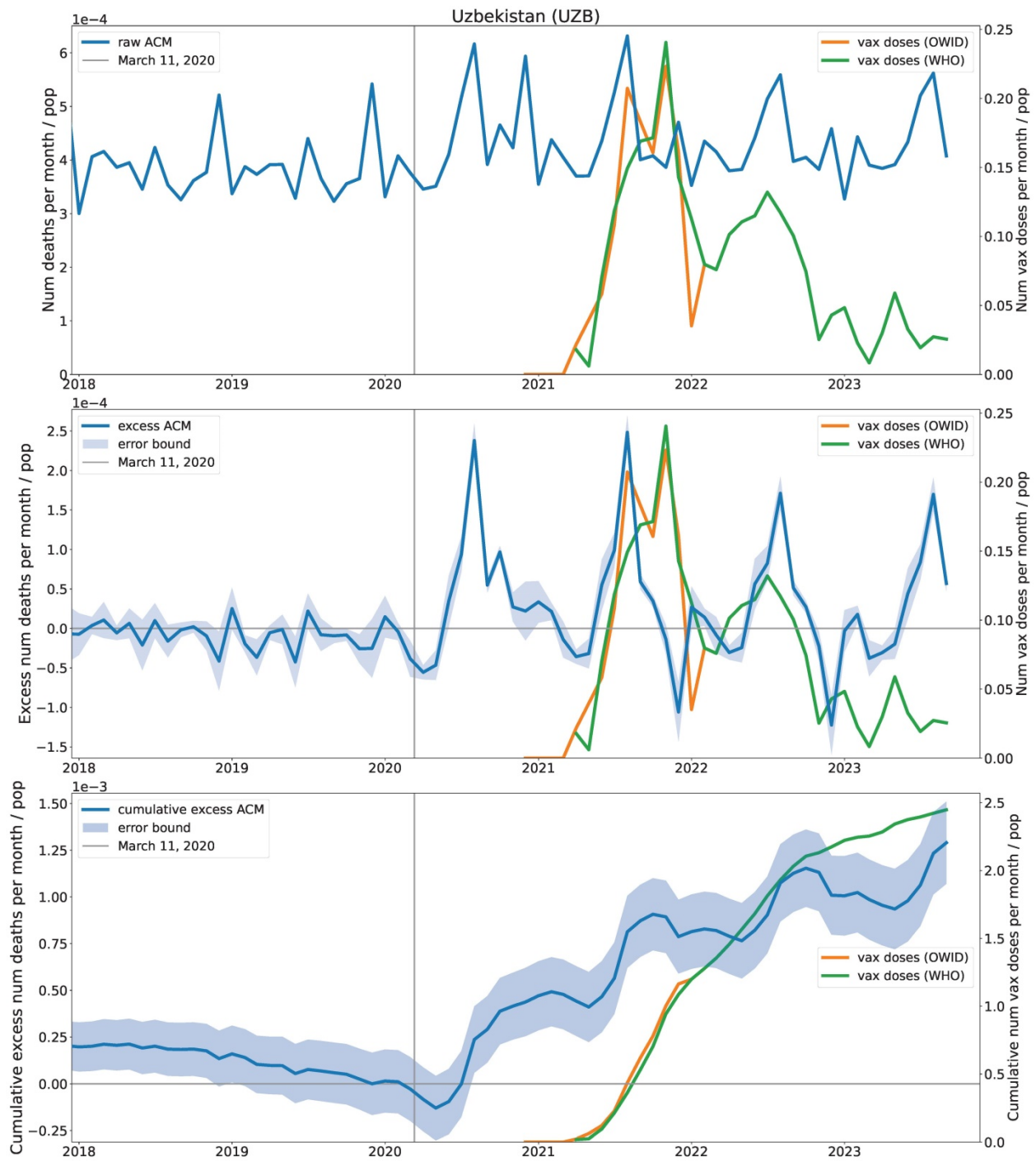












End of Appendix B

Appendix C: Table of excess all-cause mortality 2020-2022, as rate per 2019 population, and as P-score, for the 93 countries with sufficient data, in decreasing order of population

Mortality data columns: xACM 2020-2022 (X202122) -- its error -- baseline historic ACM 2020-2022 (H202122) -- its error -- xACM 2020-2022 rate by 2019 population (X/pop) -- its error -- P-score 2020-2022 -- its error -- (see Section 4.9)

Country Name	Code	Population (2019)	X202122	err (X202122)	H202122	err (H202122)	X/pop (%)	err (X/pop%)	X/hist (%)	P-score	err (X/hist%)
United States	USA	328,329,953	1,392,962	14,855	8,636,491	14,514	0.4243	0.0045	16.13	0.20	
Brazil	BRA	211,782,878	843,047	13,064	4,150,043	12,872	0.3981	0.0062	20.31	0.38	
Russia	RUS	144,406,261	1,340,131	24,155	5,138,692	24,022	0.9280	0.0167	26.08	0.59	
Japan	JPN	126,633,000	170,685	11,852	4,248,180	11,665	0.1348	0.0094	4.02	0.29	
Mexico	MEX	125,085,311	709,033	6,327	2,271,473	6,087	0.5668	0.0051	31.21	0.36	
Philippines	PHL	110,380,804	253,877	7,895	1,919,253	7,756	0.2300	0.0072	13.23	0.46	
Egypt	EGY	105,618,671	356,011	16,769	1,657,368	16,710	0.3371	0.0159	21.48	1.23	
Turkey	TUR	83,481,684	252,688	10,155	1,327,683	10,078	0.3027	0.0122	19.03	0.91	
Germany	DEU	83,092,962	264,713	13,404	2,775,578	13,290	0.3186	0.0161	9.54	0.53	
Thailand	THA	71,307,763	157,351	11,902	1,503,701	11,832	0.2207	0.0167	10.46	0.87	
France	FRA	67,388,001	166,250	7,569	1,769,150	7,440	0.2467	0.0112	9.40	0.47	
United Kingdom	GBR	66,836,327	244,415	8,888	1,749,595	8,775	0.3657	0.0133	13.97	0.58	
Italy	ITA	59,729,081	303,446	9,278	1,841,103	9,162	0.5080	0.0155	16.48	0.59	
South Africa	ZAF	58,087,055	248,980	4,470	1,569,515	4,262	0.4286	0.0077	15.86	0.33	
South Korea	KOR	51,764,822	77,877	2,939	907,896	2,767	0.1504	0.0057	8.58	0.35	
Colombia	COL	50,187,406	190,870	1,780	748,901	1,493	0.3803	0.0035	25.49	0.28	
Spain	ESP	47,134,837	188,935	5,806	1,202,206	5,685	0.4008	0.0123	15.72	0.56	
Poland	POL	37,965,475	207,038	5,337	1,224,080	5,202	0.5453	0.0141	16.91	0.51	
Canada	CAN	37,601,230	73,568	2,275	873,591	2,057	0.1957	0.0061	8.42	0.28	
Uzbekistan	UZB	33,580,350	33,881	4,342	488,370	4,282	0.1009	0.0129	6.94	0.95	
Malaysia	MYS	32,804,020	42,953	2,168	551,194	2,027	0.1309	0.0066	7.79	0.42	
Australia	AUS	25,340,217	17,620	1,371	503,282	1,166	0.0695	0.0054	3.50	0.28	
Taiwan	TWN	23,600,000	29,706	5,378	534,411	5,326	0.1259	0.0228	5.56	1.06	

Romania	ROU	19,371,648	134,276	3,766	759,100	3,645	0.6932	0.0194	17.69	0.58
Chile	CHL	19,039,485	59,544	1,166	337,317	982	0.3127	0.0061	17.65	0.39
Kazakhstan	KAZ	18,513,673	86,870	3,543	393,808	3,475	0.4692	0.0191	22.06	1.09
Netherlands	NLD	17,344,874	53,443	1,874	449,963	1,735	0.3081	0.0108	11.88	0.46
Ecuador	ECU	17,343,740	81,814	1,040	227,961	879	0.4717	0.0060	35.89	0.58
Guatemala	GTM	16,604,026	53,197	1,037	253,360	878	0.3204	0.0062	21.00	0.47
Tunisia	TUN	12,049,314	39,913	1,881	212,677	1,813	0.3312	0.0156	18.77	1.04
Belgium	BEL	11,488,980	38,278	1,784	313,572	1,684	0.3332	0.0155	12.21	0.63
Cuba	CUB	11,316,697	57,381	2,613	342,810	2,536	0.5070	0.0231	16.74	0.88
Greece	GRC	10,721,582	49,920	2,074	361,572	1,973	0.4656	0.0193	13.81	0.65
Jordan	JOR	10,698,683	17,093	1,097	86,135	1,049	0.1598	0.0103	19.84	1.51
Czechia	CZE	10,671,870	54,481	1,821	330,209	1,713	0.5105	0.0171	16.50	0.63
Portugal	PRT	10,286,263	44,902	2,076	324,327	1,985	0.4365	0.0202	13.84	0.72
Sweden	SWE	10,278,887	21,398	1,129	259,934	997	0.2082	0.0110	8.23	0.46
Azerbaijan	AZE	10,024,283	42,605	1,581	170,729	1,513	0.4250	0.0158	24.95	1.14
Hungary	HUN	9,771,141	53,933	2,337	374,209	2,244	0.5520	0.0239	14.41	0.71
Israel	ISR	9,054,000	16,475	656	133,046	531	0.1820	0.0072	12.38	0.53
Austria	AUT	8,879,920	29,869	1,348	238,839	1,245	0.3364	0.0152	12.51	0.63
Switzerland	CHE	8,575,280	22,741	1,115	196,328	1,013	0.2652	0.0130	11.58	0.62
Hong Kong	HKG	7,507,900	18,932	1,278	145,143	1,212	0.2522	0.0170	13.04	0.98
Bulgaria	BGR	6,975,761	77,376	1,769	310,377	1,657	1.1092	0.0254	24.93	0.70
Serbia	SRB	6,945,235	69,860	3,304	293,729	3,249	1.0059	0.0476	23.78	1.38
Paraguay	PRY	6,530,026	27,151	917	104,577	843	0.4158	0.0140	25.96	1.07
Kyrgyzstan	KGZ	6,456,200	13,678	763	96,892	687	0.2119	0.0118	14.12	0.88
Denmark	DNK	5,814,422	7,830	693	161,587	558	0.1347	0.0119	4.85	0.44
Singapore	SGP	5,703,569	6,076	495	67,160	415	0.1065	0.0087	9.05	0.78
Finland	FIN	5,521,606	13,795	751	160,843	625	0.2498	0.0136	8.58	0.50
Slovakia	SVK	5,454,147	33,652	962	155,558	859	0.6170	0.0176	21.63	0.73
Norway	NOR	5,347,896	9,157	611	117,863	496	0.1712	0.0114	7.77	0.55
Costa Rica	CRI	5,084,532	7,332	570	78,900	489	0.1442	0.0112	9.29	0.77
New Zealand	NZL	4,979,200	-1,542	506	106,753	389	-0.0310	0.0102	-1.44	0.47
Ireland	IRL	4,934,340	10,396	555	91,468	454	0.2107	0.0112	11.37	0.65
Oman	OMN	4,602,768	4,757	376	28,130	329	0.1034	0.0082	16.91	1.51
Kuwait	KWT	4,441,100	7,052	250	22,495	182	0.1588	0.0056	31.35	1.31
Croatia	HRV	4,065,253	27,860	1,012	147,105	922	0.6853	0.0249	18.94	0.80
Georgia	GEO	3,720,161	28,787	1,336	130,773	1,276	0.7738	0.0359	22.01	1.23
Uruguay	URY	3,428,409	5,336	974	107,791	914	0.1556	0.0284	4.95	0.94
Bosnia	BIH	3,360,711	25,716	1,060	105,254	996	0.7652	0.0315	24.43	1.23
Mongolia	MNG	3,232,430	664	509	53,169	453	0.0205	0.0157	1.25	0.97
Puerto Rico	PRI	3,193,694	10,055	606	89,136	519	0.3148	0.0190	11.28	0.74
Albania	ALB	2,854,191	18,117	850	62,967	801	0.6348	0.0298	28.77	1.70
Armenia	ARM	2,820,602	24,095	903	72,605	848	0.8543	0.0320	33.19	1.61
Qatar	QAT	2,807,235	1,349	114	6,740	70	0.0481	0.0041	20.01	1.83

Lithuania	LTU	2,794,137	26,248	668	105,761	562	0.9394	0.0239	24.82	0.75
Moldova	MDA	2,664,224	21,083	999	101,572	936	0.7913	0.0375	20.76	1.16
Slovenia	SVN	2,088,385	8,107	449	60,747	365	0.3882	0.0215	13.35	0.81
North Macedonia	MKD	2,076,694	17,952	747	58,662	694	0.8645	0.0360	30.60	1.62
Latvia	LVA	1,913,822	11,937	504	80,782	402	0.6237	0.0263	14.78	0.68
Kosovo	KOS	1,788,878	5,609	272	29,533	198	0.3135	0.0152	18.99	1.02
Estonia	EST	1,326,898	5,617	356	45,394	276	0.4233	0.0268	12.37	0.84
Mauritius	MUS	1,265,711	1,913	303	35,358	234	0.1511	0.0239	5.41	0.89
Cyprus	CYP	1,228,836	2,878	215	17,877	160	0.2342	0.0175	16.10	1.32
Réunion	REU	949,419	1,182	175	16,065	117	0.1245	0.0184	7.36	1.13
Macao	MAC	663,653	765	143	6,788	114	0.1153	0.0215	11.27	2.26
Montenegro	MNE	622,028	3,762	235	19,464	180	0.6048	0.0378	19.33	1.35
Luxembourg	LUX	620,001	236	173	13,206	129	0.0381	0.0279	1.79	1.32
Malta	MLT	504,062	1,417	164	10,886	121	0.2811	0.0325	13.02	1.62
Brunei	BRN	438,048	509	119	5,429	91	0.1162	0.0272	9.38	2.32
Guadeloupe	GLP	384,239	1,537	154	10,566	108	0.4000	0.0401	14.55	1.57
Martinique	MTQ	364,508	1,521	148	10,807	98	0.4173	0.0406	14.07	1.46
Iceland	ISL	360,563	535	117	6,733	81	0.1484	0.0324	7.95	1.82
French Guiana	GUF	290,932	316	80	3,104	55	0.1086	0.0275	10.18	2.71
Barbados	BRB	280,180	462	206	8,499	183	0.1649	0.0735	5.44	2.53
New Caledonia	NCL	271,230	416	111	5,008	84	0.1534	0.0409	8.31	2.33
Mayotte	MYT	270,372	545	70	2,401	45	0.2016	0.0259	22.70	3.23
Seychelles	SYC	97,625	-69	71	2,603	51	-0.0707	0.0727	-2.65	2.71
Greenland	GRL	56,225	-70	58	1,648	43	-0.1245	0.1032	-4.25	3.48
Faroe Islands	FRO	51,681	22	46	1,260	29	0.0426	0.0890	1.75	3.70
Monaco	MCO	37,034	223	60	1,445	44	0.6021	0.1620	15.43	4.52
San Marino	SMR	34,178	150	42	767	30	0.4389	0.1229	19.56	6.08

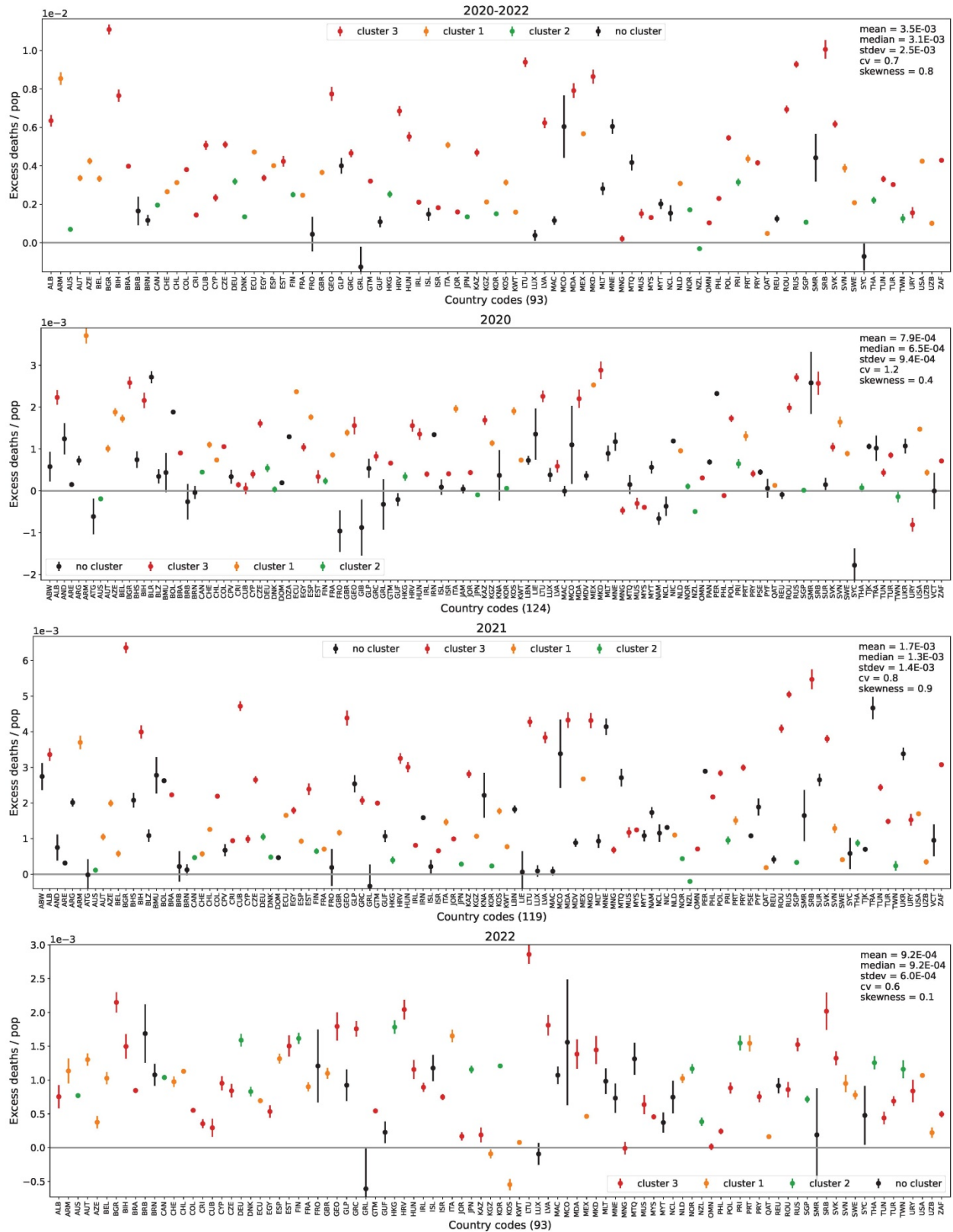
Appendix D: Excess all-cause mortality for various time periods, expressed as a fraction of the 2019 population, by country

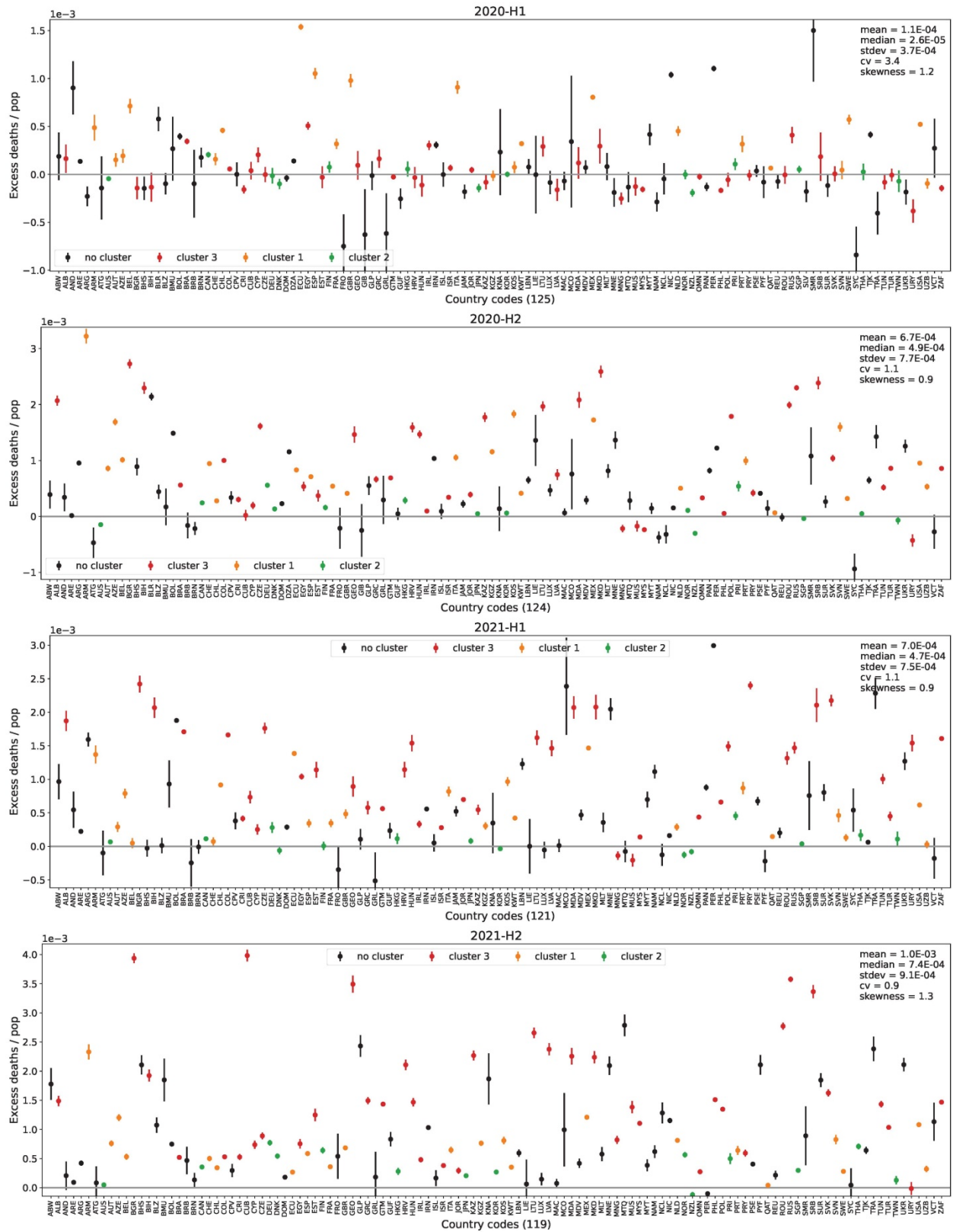
The figure in this Appendix has 11 consecutive panels, in order of the time periods considered.

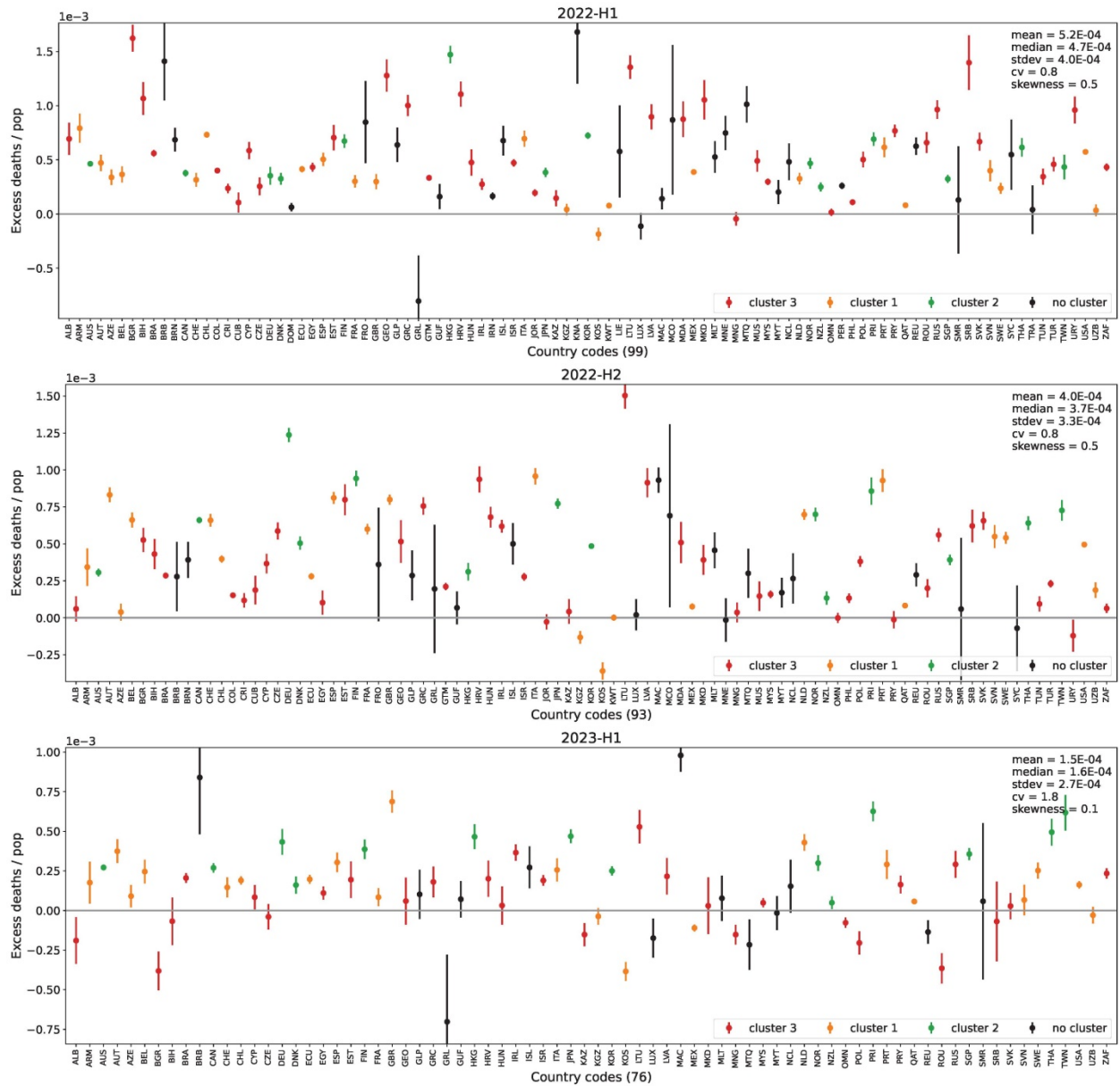
Each panel shows excess all-cause mortality versus country code (by country, as labelled, with country codes in alphabetical order), for a given time period (as labelled for each panel: 2020-2022, 2020, 2021, 2022, and each half calendar year 2020-H1 through 2023-H1), expressed as a fraction (not percentage) of 2019 population, with 1σ error bars, with the points colour coded by hierarchical cluster.

Each panel shows a legend with the values of the mean, median, standard deviation, coefficient of variation (standard deviation / mean), and skewness (Fisher-Pearson coefficient of skewness), for the data in the panel. The number (N) of countries is given in parentheses at the bottom of each panel, for each time period.

In the labels of axes and in legends in all figures, throughout the present article, “1e-4” or “1E-4” means “times 10^{-4} ”, and so forth (following scientific and computer-programming notation).







End of Appendix D

Rancourt - Hickey - Linard

Spatiotemporal variation of excess all-cause mortality in the world (125 countries) during the Covid period 2020-2023 regarding socio economic factors and public-health and medical interventions.

CORRELATION Research in the Public Interest, Report, 19 July 2024.

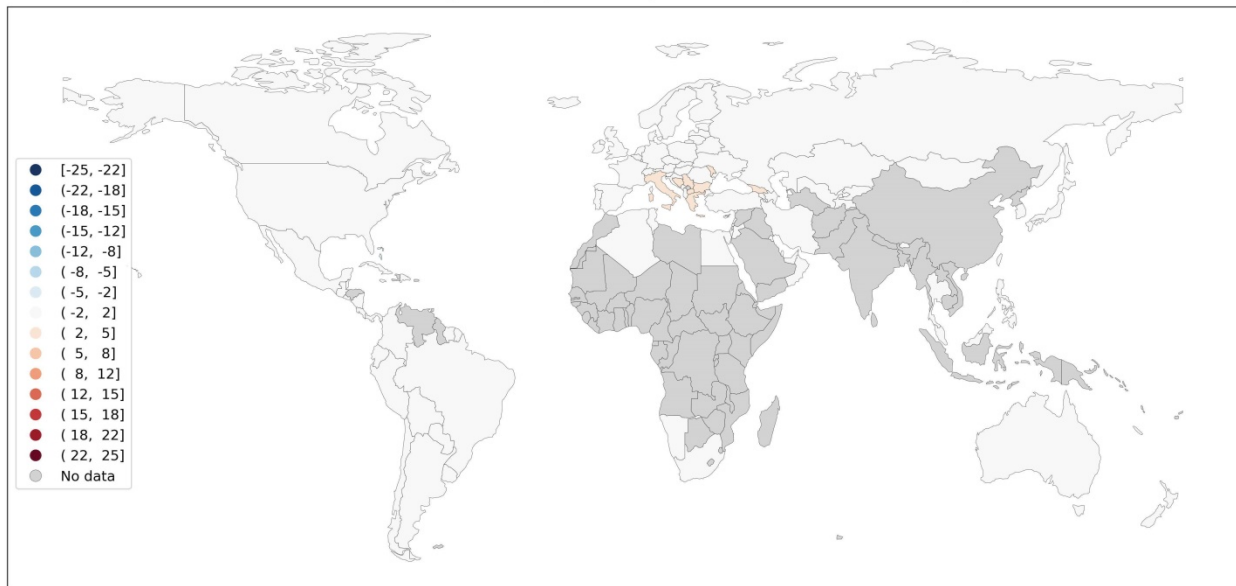
<https://correlation-canada.org/covid-excess-mortality-125-countries>

Appendix E: Temporal sequence of world maps of excess all-cause mortality by population, through the Covid period by half years

The figure in this appendix has 9 panels (9 world maps), for the half years 2019-H1 through 2023-H1, in chronological order.

The colour coding is capped at 25 excess deaths per 10k population for all the maps to aid visualization.

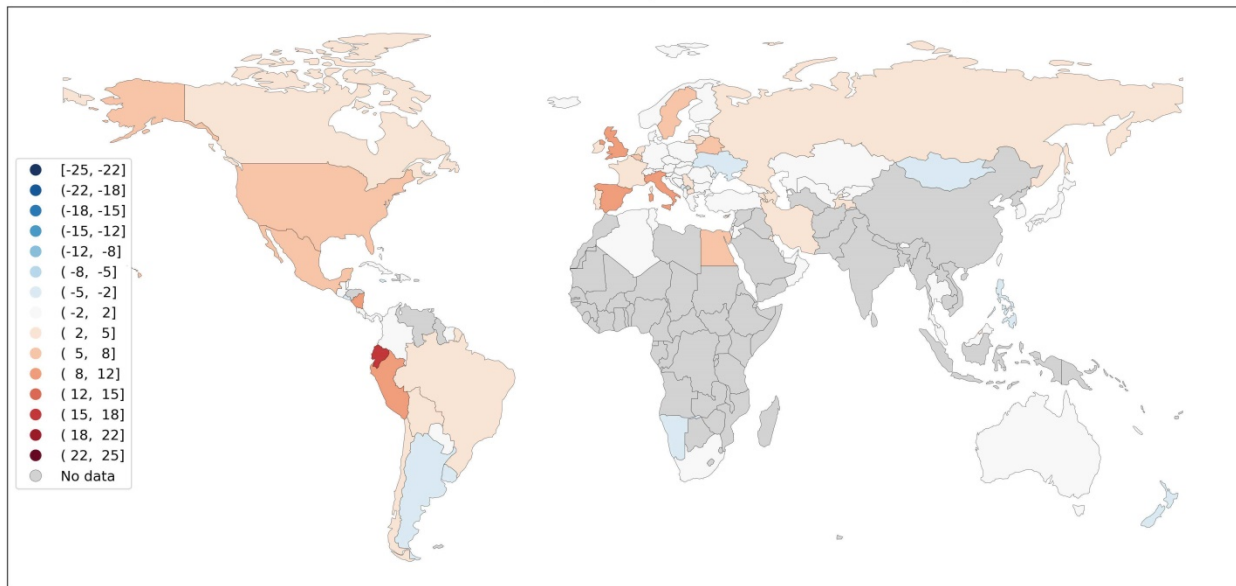
Excess deaths per 10k persons (2019-01-01 to 2019-06-30)



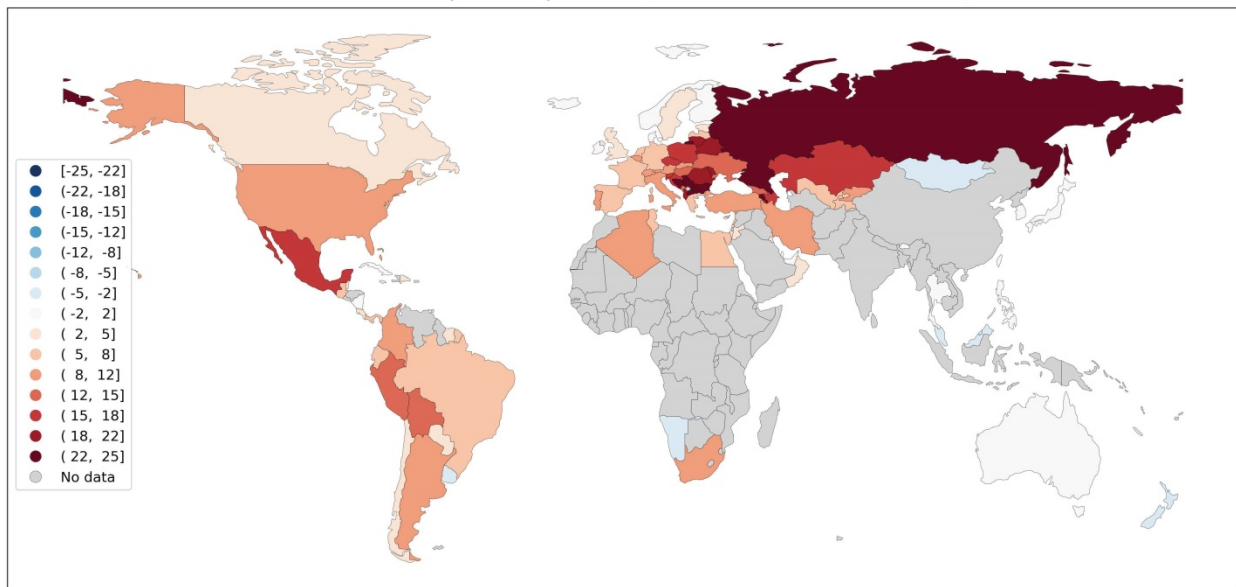
Excess deaths per 10k persons (2019-07-01 to 2019-12-31)



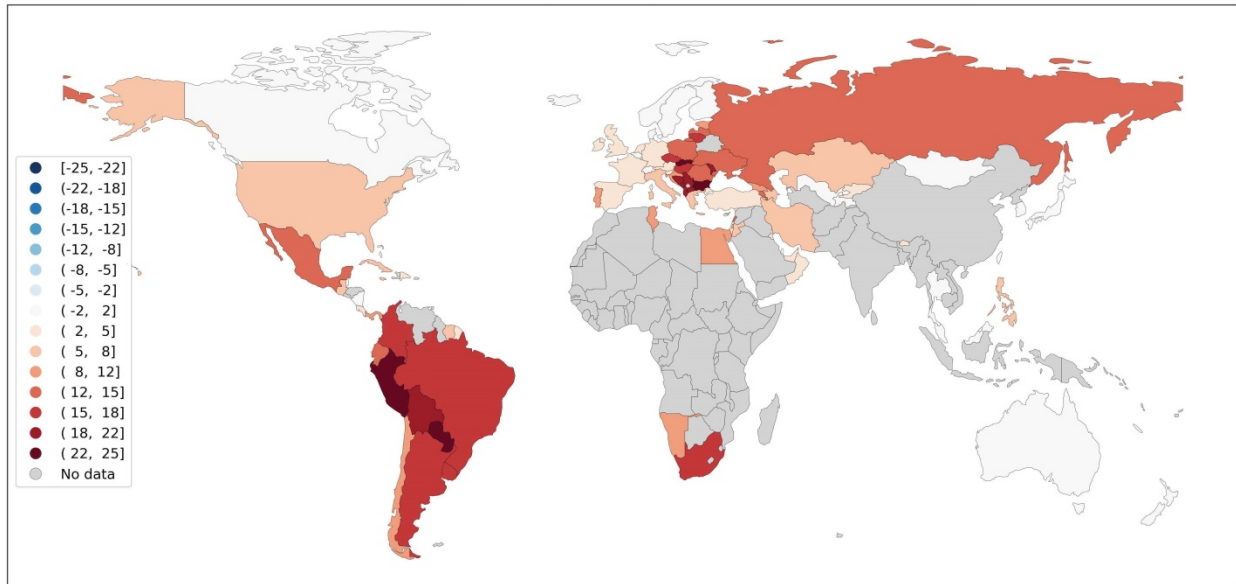
Excess deaths per 10k persons (2020-01-01 to 2020-06-30)



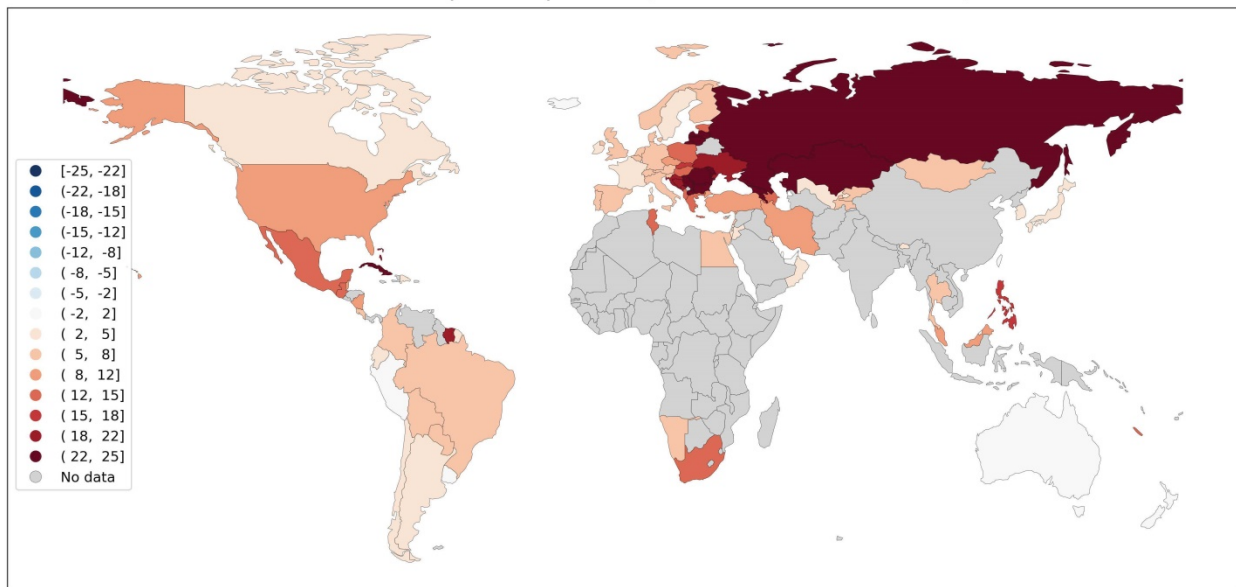
Excess deaths per 10k persons (2020-07-01 to 2020-12-31)



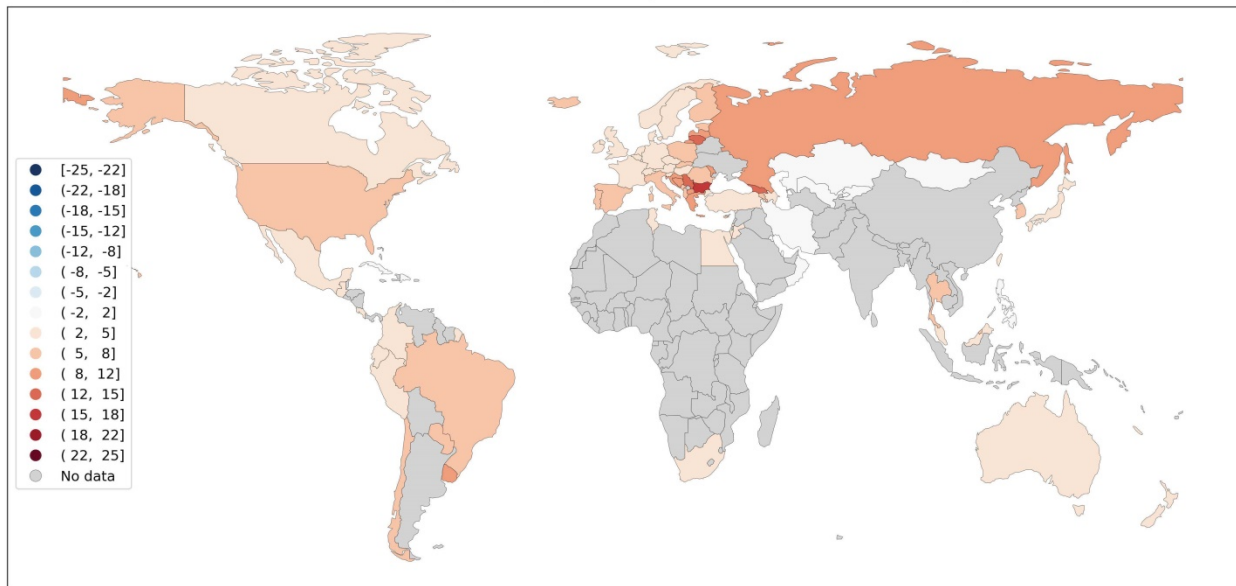
Excess deaths per 10k persons (2021-01-01 to 2021-06-30)



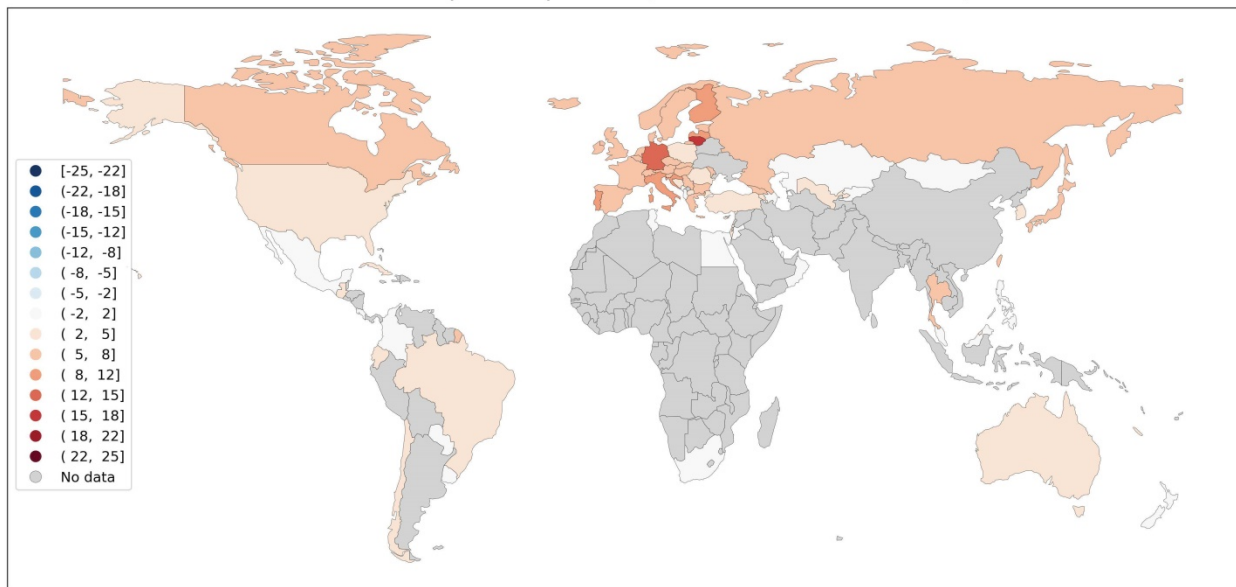
Excess deaths per 10k persons (2021-07-01 to 2021-12-31)



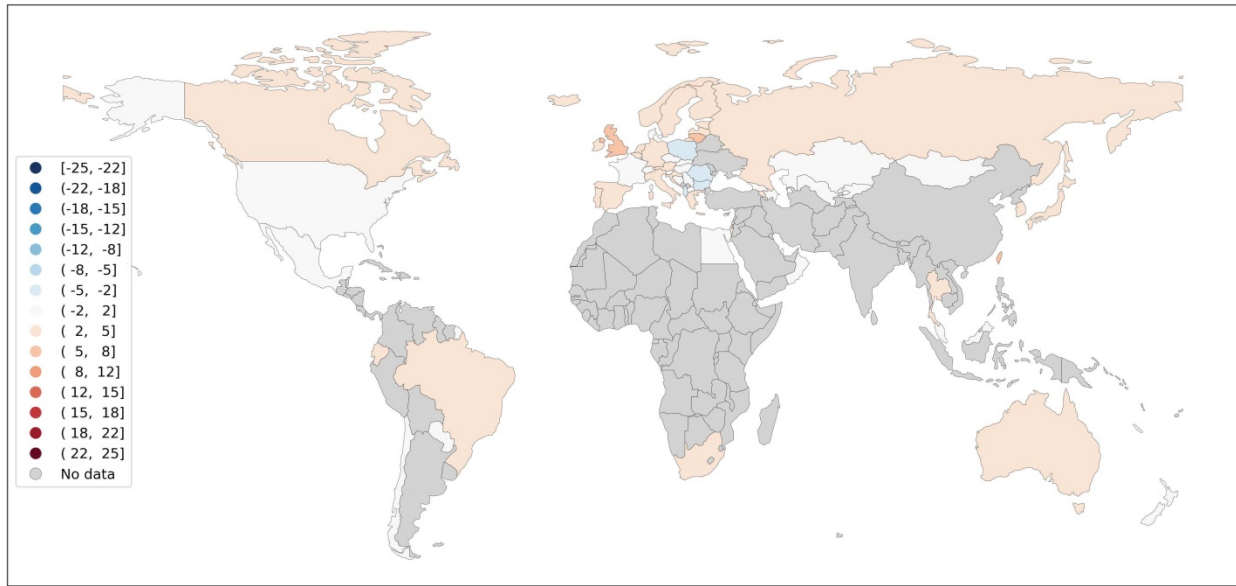
Excess deaths per 10k persons (2022-01-01 to 2022-06-30)



Excess deaths per 10k persons (2022-07-01 to 2022-12-31)

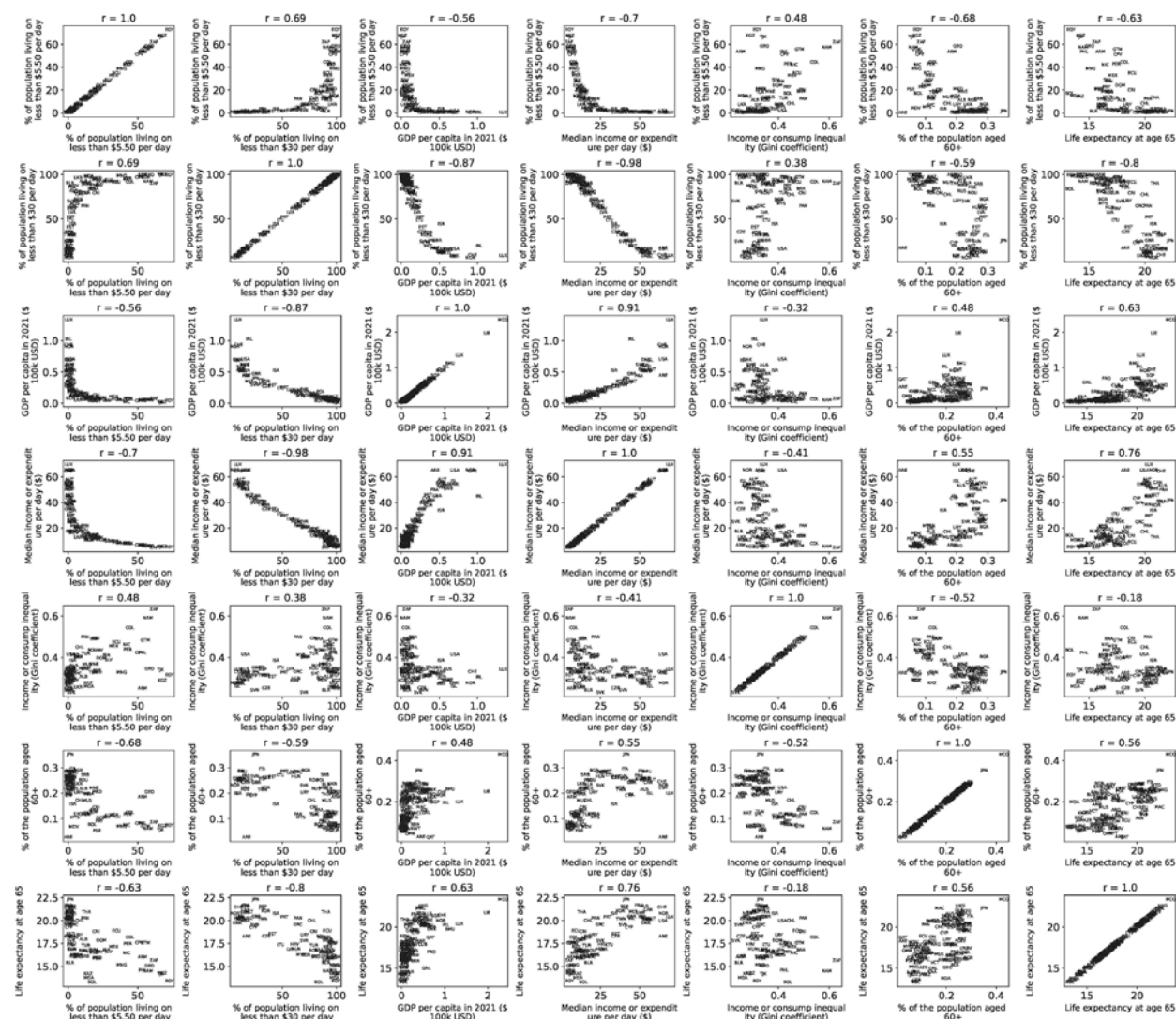


Excess deaths per 10k persons (2023-01-01 to 2023-06-30)



End of Appendix E

Appendix F: Scatter plots of relations between socio-economic variables



Appendix G: Table of Pearson correlation coefficients between socio-economic variables

SOCIO-ECONOMIC VARIABLE	% of population living on less than \$5.50 per day	% of population living on less than \$30 per day	GDP per capita in 2021 (\$100k USD)	Median income or expenditure per day (\$)	Income or consump inequality (Gini coefficient)	% of the population aged 60+	Life expectancy at age 65
% of population living on less than \$5.50 per day	1	0.69	-0.56	-0.7	0.48	-0.68	-0.63
% of population living on less than \$30 per day	0.69	1	-0.87	-0.98	0.38	-0.59	-0.8
GDP per capita in 2021 (\$100k USD)	-0.56	-0.87	1	0.91	-0.32	0.48	0.63
Median income or expenditure per day (\$)	-0.7	-0.98	0.91	1	-0.41	0.55	0.76

Income or consump inequality (Gini coefficient)	0.48	0.38	-0.32	-0.41	1	-0.52	-0.18
% of the population aged 60+	-0.68	-0.59	0.48	0.55	-0.52	1	0.56
Life expectancy at age 65	-0.63	-0.8	0.63	0.76	-0.18	0.56	1

Appendix H: Tables of Pearson correlation coefficients between excess all-cause mortality and socio-economic variables, in different time periods

1 of 2: Using excess all-cause mortalities normalized by baseline historic mortality (P-score)

	2020- 2022	2020- H1	2020- H2	2021- H1	2021- H2	2022- H1	2022- H2	2023- H1	2020- 2023-H1
GDP per capita in 2021 (\$100k USD)	-0.368	-0.013	-0.238	-0.300	-0.362	-0.100	0.297	0.225	-0.511
Income or consumption inequality (Gini coeff.)	0.227	0.154	-0.007	0.394	0.039	0.169	-0.327	0.061	0.271
% of population living on less than \$5.50 / day	0.394	0.178	0.258	0.310	0.345	0.008	-0.540	-0.216	0.398
% of population living on less than \$30 / day	0.544	0.035	0.394	0.500	0.573	0.204	-0.661	-0.419	0.634
Median income or expenditure per day (\$)	-0.533	-0.028	-0.366	-0.484	-0.533	-0.225	0.607	0.347	-0.618

Life expectancy at age 65	-0.326	0.060	-0.315	-0.325	-0.446	0.032	0.516	0.440	-0.345
% of the population aged 60+	-0.153	-0.136	-0.096	-0.314	-0.162	0.054	0.384	0.074	-0.131
% of the population aged 90+	-0.146	-0.032	-0.158	-0.156	-0.229	0.006	0.218	0.154	-0.241

2 of 2: Using excess all-cause mortality rates (normalized by 2019 population)

	2020-2022	2020-H1	2020-H2	2021-H1	2021-H2	2022-H1	2022-H2	2023-H1	2020-2023-H1
GDP per capita in 2021 (\$100k USD)	-0.256	0.045	-0.174	-0.228	-0.244	-0.111	0.256	0.186	-0.493
Income or consumption inequality (Gini coeff.)	-0.020	0.057	-0.180	0.226	-0.079	-0.053	-0.375	-0.011	0.092
% of population living on less than \$5.50 / day	0.113	0.074	0.057	0.175	0.098	-0.135	-0.524	-0.238	0.152
% of population living on less than \$30 per day	0.391	-0.067	0.291	0.493	0.380	0.155	-0.555	-0.449	0.494
Median income or expenditure per day (\$)	-0.372	0.060	-0.258	-0.488	-0.352	-0.158	0.510	0.377	-0.476

Life expectancy at age 65	-0.275	0.145	-0.279	-0.315	-0.336	-0.017	0.423	0.458	-0.339
% of the population aged 60+	0.375	0.068	0.249	0.124	0.243	0.437	0.702	0.240	0.366
% of the population aged 90+	0.130	0.107	0.010	0.106	0.000	0.209	0.412	0.344	0.080

Appendix I: Tables of Pearson correlation coefficients between excess all-cause mortality and number of vaccine injections by population, for different time periods

1 of 2: Using excess all-cause mortalities normalized by baseline historic mortality (P-score)

	2020- 2022	2020- H1	2020- H2	2021- H1	2021- H2	2022- H1	2022- H2	2023-H1
vaxN 2021- 2022 (WHO) per 2019 pop	-0.473	0.225	-0.324	-0.166	-0.533	-0.098	0.433	0.472
vaxN 2021 (WHO) per 2019 pop	-0.479	0.162	-0.422	-0.219	-0.481	-0.110	0.454	0.461
vaxN 2022 (WHO) per 2019 pop	-0.325	0.349	-0.101	-0.024	-0.397	-0.098	0.261	0.371

2 of 2: Using excess all-cause mortality rates (normalized by 2019 population)

	Excess deaths per pop (2020- 2022)	Excess deaths per pop (2020- 2023- H1)	Excess deaths per pop (2020- H1)	Excess deaths per pop (2020- H2)	Excess deaths per pop (2021- H1)	Excess deaths per pop (2021- H2)	Excess deaths per pop (2022- H1)	Excess deaths per pop (2022- H2)	Excess deaths per pop (2023- H1)
vaxN 2021- 2022 (WHO) per 2019 pop	-0.554	-0.554	0.213	-0.396	-0.309	-0.511	-0.322	0.218	0.409
vaxN 2021 (WHO) per 2019 pop	-0.467	-0.480	0.156	-0.414	-0.312	-0.409	-0.251	0.284	0.428
vaxN 2022 (WHO) per 2019 pop	-0.509	-0.511	0.320	-0.233	-0.234	-0.478	-0.364	0.042	0.301

Appendix J: Correction and extension of the analysis by Ioannidis et al. (2023) — excess all-cause mortality in “less and more vulnerable” countries

This appendix has 3 composite panels. Each composite panel presents and compares the countries used in the study by Ioannidis et al. (2023), alone or with more countries, and using our excess all-cause mortality quantification method (rather than the method used by Ioannidis et al., 2023).

All subpanels are in left-right pairs, with the country codes shown in the partner on the right.

Each composite panel shows P-score for the entire Covid period (half years 2020-H1 through 2023-H1) (y-axis) versus each of the three socio-economic parameters used by Ioannidis et al. (2023) (x-axis: GDP, top; Gini coefficient, middle; share population living with <\$5.50/day, bottom). Pearson correlation coefficients are indicated for all plots (top-right).

First composite panel: Only countries included by Ioannidis et al. (2023), labelled by them as “vulnerable” (red) and “less vulnerable” (green).

Second composite panel: Same, adding countries with presently available data not considered by Ioannidis et al. (2023) (in black).

Third composite panel: All countries discerned by colour, as labelled in the legend of the top-left subpanel.

